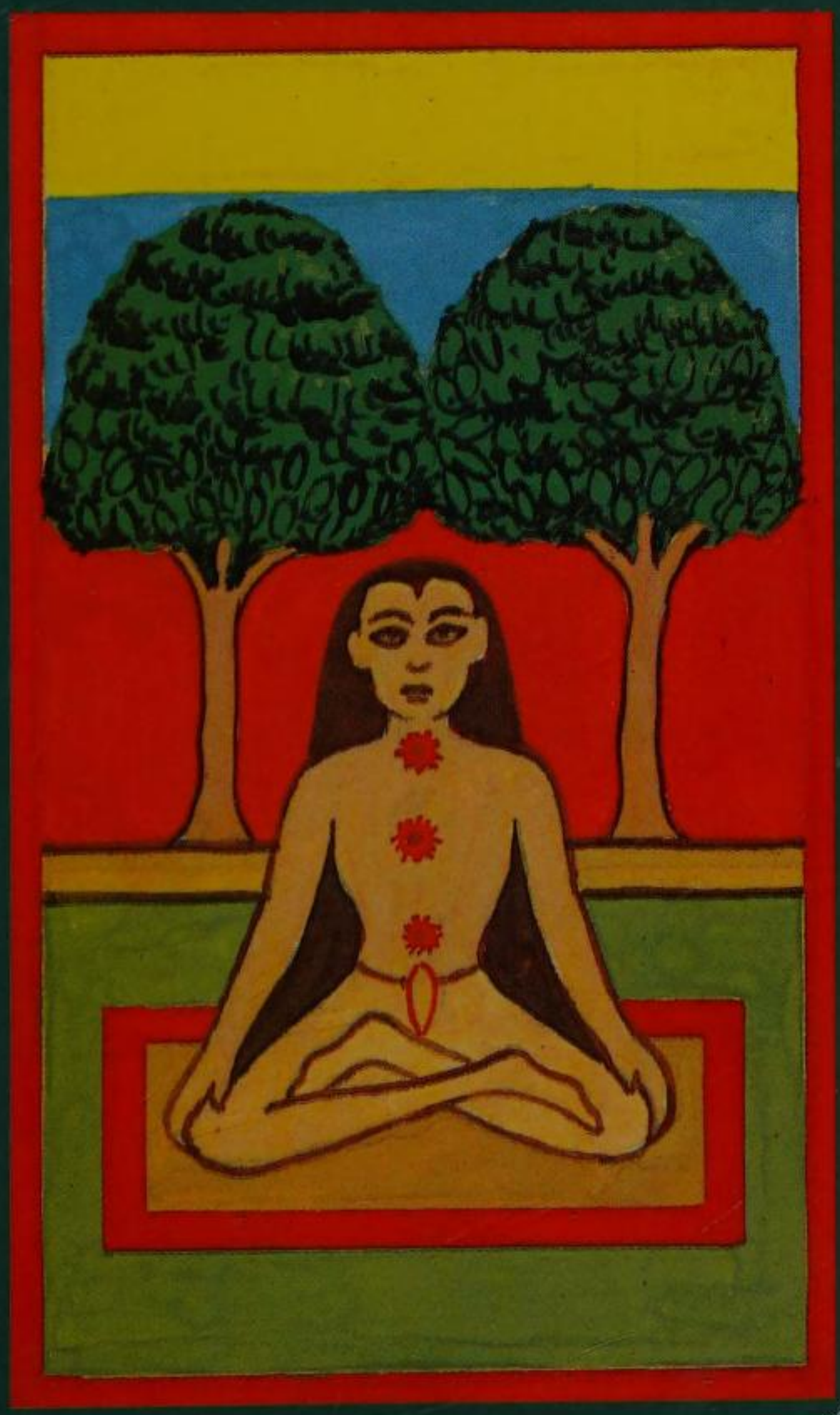
Stress and its Management by Yoga



K.N.Udupa

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This monograph mainly covers our studies on the causes and management of the most common and disabling disorders of stress and strain of life. It is now well established that the brain with its known centres for sensory, intellectual and emotional functions plays the main role in maintaining a balanced condition of our body and mind by liberating required amount of neurohumors and hormones. Any disturbance of this homeostasis by genetic or environmental factors would ultimately lead to the development of the Stress Disorders. At first the changes are functional and later on bodily changes of Stress Disorders appear. In the treatment, during the acute stage, the use of tranquillizers and other drugs may help. However, if the disturbance persists, the practice of Yoga would help greatly to get over the neuro-humoral changes occurring in the brain. Hence the integrated practice of Yoga has an important role to play in the prevention and treatment of Stress Diseases. All these aspects have been dealt with in the book in sufficient detail with regard to each of the disorders of stress for the benefit of all concerned.

STRESS AND ITS MANAGEMENT BY YOGA

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K.N. UDUPA

Edited by
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Preface to the Second Edition

It is gratifying to note that scientists and scientifically minded people are now taking greater interest in exploring the truth of Yoga and its influence on the humanity as a whole. That is perhaps one of the reasons why there is more demand for books of this type, dealing with the physiological and biochemical aspects of Yoga.

Although the format of this book remains almost the same as that of the first edition, a few additions have been made at some places. The following are some of the important additions: (a) Kundalini Yoga: A new chapter on Kundalini Yoga has been added to explain the science and practice of this important branch of Tantra/Yoga; (b) Meditation: the chapter on meditation has been expanded to include recent trends in the study of consciousness and meditation; (c) Social aspects of Yoga: Lastly, as an Epilogue, social aspects of Yoga have been discussed in some detail because it is felt that apathy to conducting Yoga research on the part of scientists and medical men on the one side and the traditional yogis on the other has greatly retarded the growth of this ancient science. Unless all these experts join their hands for conducting further studies, we will never be able to make further advances in the field of Yoga in the near future.

Further, in order to implement the Alma Mater declaration of "Health for all by the year 2000 A. D. ", specially for the promotion of mental health, Yoga and Meditation can play a great role provided proper scientific studies are conducted to establish their usefulness. Various scientific studies already conducted give sufficient proof in favour of the statement that the use of Yoga as a health promotive, preventive and curative

procedure has provided enormous benefit to the people all over the world at a minimal effort and cost. Therefore let us pool all our resources to spread the message of Yoga for promoting universal health and happiness.

The purpose of writing this book will be fully served, if, in addition to providing guidance to the common man to attain better health, it also stimulates the elites of the society to dive deep into the subject. I sincerely hope that it will fulfil the purpose for which it has been written.

Varanasi K.N.UDUPA

Preface to the First Edition

I am happy to present herewith a monograph on "Disorders of Stress and their Management by Yoga" (A study of neurohumoral response) for the benefit of all those interested in the subject. This book is mainly based on our experience of managing these patients at the University Hospital, Banaras Hindu University. My interest in the subject dates back from about two decades when I myself was the victim of one of the stress diseases known at that time as "Cardiac Neurosis". The use of some of the tranquillisers at the initial stage followed by a regular practice of Yoga gave me complete relief. How such a change was brought about in my life from a state of nervous wreck to that of an active creative life by the use of Yoga was the subject of my enquiry in the subsequent years.

I read many medical books and monographs which gave vivid descriptions of most of the stress diseases from hypertension to migraine with no satisfactory answer to the question of their prevention. In the same way I read many books on Yoga too, from ancient authors to the modern scholars with no satisfactory answers. None of these books could give me a scientific explanation as to how these stress disorders are actually caused and why they are increasing at such a rapid rate all over the world. Hence I felt that there was a pressing need for further study of the various causative factors which are responsible for the development of these stress diseases. Similarly, there was also an urgent need to explore scientifically as to how 'Yoga ' could act as an important measure with beneficial results to these patients from the preventive as well as the curative point of view.

It is because of these pressing considerations that we started working in this area. In fact the present monograph is the result of these studies carried out by myself and my colleagues for the last several years. In the beginning, when we started exploring the literature on the physiopathology of stress, we noted two distinct schools of thought One school working mostly on smaller animals believed that the hypothalamus and its neuro-endocrine apparatus are the highest centres for producing all the bodily disturbances of stress. But there was another group mostly belonging to the Pavlov school of physiology believing that it was the cerebral cortext which regulated all the abnormal symptoms manifested in stress. However, we are happy to state that our own studies of all the neurohumors indicated a complete integration of both the above hypotheses. Thus it is at first the cerebral cortex that is stimulated by stress. The hypothalamus and the entire neuroendocrine apparatus are stimulated subsequently to the cerebral cortex. It is also by the cerebral cortex that the autonomic nerves are stimulated via limbic system and hypothalamus which ultimately cause the disease proper in a given organ or tissue. From the above, one can say that it is the neurohumors which are the main connecting links between the cerebral cortex and all the bodily systems.It is surprising to note that all the modern neurohumoral theories to be described in this monograph closely resemble the one put forward about 2000 years ago by ancient medical authorities of the East and the West.

When we started investigating the effects of yogic practice on health and disease we followed several modern clinical, physiological and biochemical methods. However, we soon came to the conclusion that the neurohumoral studies are the most fruitful methods for finding out the efficacy of various yogic practices in the management of stress diseases.

The word 'yoga' is generally misunderstood by people. To some, it means a particular type of exercise, whereas to others it is meditation. As I understand the word,it means Patanjali's integrated type of yoga which includes yogic exercises, breath

holding practices and meditation. However, in the management of stress diseases one will have to make a selection and advise the type of yoga which is best suited to a patient to get over that particular disorder.

On the basis of the above stated principles, we carried on our studies on the use of various yogic practices in the management of some of the well known stress diseases, using neurohumoral studies as the main parameter for assessing the results. The results of these studies were very instructive and rewarding not only in the field of therapy, but also for understanding the pathogenesis and pathology of these stress diseases. Hence, a brief review of the pathogenesis and pathology of these diseases is also given after considering the various aspects of the Physiology and Biochemistry of nervous system. Thereafter, specific disorders have been discussed briefly and our experience with the management of these cases by yoga has been given in some detail.

From all these studies we are convinced that it is the cerebral cortex, specially the psychic centre, which is responsible for the initiation of all these stress disorders as a result of genetic susceptibility of a person receiving excessive environmental stimulation. Thus, the cerebral cortex in response to a strong stimulus initiates the changes in the whole body through the prompt liberation of neurohumors and hormones in an excessive quantity. It is at this stage that yogic practices would greatly help the patients to get over their trouble by decreasing their sensitivity to the environmental stimulation and thereby to these neurohumoral and hormonal changes. Because of the enormous benefits derived from so simple and inexpensive a measure as yoga in the management of these patients, who are otherwise destined to become neurotics or drug addicts, we have dealt with the subject in sufficient detail. It is hoped that medical men and other scientists will ponder over these pressing problems and take effective measures so that they can provide a lasting relief to their patients based on these scientific studies. We hope the readers will take this monograph in the spirit with which it has

been presented and will make the fullest use of it for conducting further studies on the subject.

September, 1978
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K.N. UDUPA
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In writing this monograph I have been greatly assisted by many of my colleagues, postgraduate students and research scholars. I express my deep sense of gratitude to all of them, without whose help this monograph could not have come to its present shape.

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Introduction

It is now well known that people of modern age suffer greatly from disorders of stress. In fact, they are the major causes of morbidity and mortality all over the world. Even now infective disorders take a great toll of lives in developing countries. But the disorders of stress and injuries are responsible for a large number of human tragedies in developed countries. Many of the accidental injuries are known to occur as a result of excess of stress and strain in life. Further, people undergoing too much of stress and strain are more liable to be affected by different types of infections than others because of poor immunological responses. If one considers all these matters together, one becomes convinced that the study of the causes and effects of stress would be one of the most important subjects of investigation for a modern medical man. Yet comparatively very few scientists and medical men have taken any interest in this subject. Hans Selye brought to the notice of the world about four decades ago cases of stress causing marked changes in the entire body in experimental animals, but very few attempts were made to apply this knowledge in solving the problems of human sufferings.

Selye, originally suggested that all the non-specific responses of stress such as hypertrophy of adrenal cortex, lymphopenia and gastro-intestinal ulcerations occurred as a result of excessive secretion of adrenocortical hormones. He further confirmed that such a response was mostly due to stimulation of anterior pituitary gland which regulated the function of the adrenal cortex through its secretion, adrenocorticotrophic hormone (ACTH). However, this was not fully accepted by most of the other physiologists. Waltor Cannon had postulated earlier that adrenal medulla and its hormone adrenaline were responsible for the appearance of various

physiological changes in the body after any type of psychosomatic stimulation. As a result of these two divergent views on the subject, not much progress could be made in the initial period.

Role of Neuroendocrines

In the meantime the extensive studies of the hypothalamus by Harris and also by Hess showed that it was the hypothalamus which regulated the functions of the anterior pituitary gland. Therefore, one could say that stress caused the stimulation of the hypothalamus which through its corticotrophic releasing factors stimulated the anterior pituitary gland to secrete more of ACTH. This in turn stimulated the adrenal cortex to pour out excess of cortisol. It is this that caused all the bodily changes in stress, which Selye called General Adaptation Syndrome. The hypothalamus is also connected with sympathetic nervous system which also becomes activated simultaneously with the changes taking place in the neuroendocrine apparatus. The stimulation of sympathetic nervous system essentially causes excess of liberation of noradrenaline. Along with this, the excessive stimulation of adrenal medulla causes an outpouring of adrenaline.

It is said that initially the adrenal medulla pours out sufficient amount of adrenaline and also some amount of noradrenaline on receipt of stressful stimuli through the neural pathways. However, for the outpouring of both of them for a prolonged period, the presence of excess quantity of plasma cortisol is also essential. Thus, there is a close correlation between the secretion of catecholamines (adrenaline and noradrenaline) and cortisol in the appearance of the effects of stress in the peripheral organs and tissues.

Even after the full knowledge of the functions of hypothalamus, pituitary gland, adrenal cortex and medulla, it was not clear how the stressful situations could stimulate the hypothalamus specifically leaving out the rest of the cerebral cortex in a normal state.

Role of Cerebral Cortex

In the meantime the Russian Schools of Physiology proposed that all these bodily changes following stress originate in the cerebral cortex. From there the stimuli reach the hypothalamic region through limbic system to produce the changes in the autonomic nervous system and in the neuroendocrine apparatus. The cerebral cortex receives environmental stressful stimuli through the normal channels of sense organs (exteroceptors) and also from the viscera, blood vessels, endocrine glands and muscles through interoceptors. All these stimuli ultimately converge at the psychic centres in the frontal lobe, from where messages are transmitted to produce various specific responses based on the earlier experiences of environmental stimuli and the genetic factors. From this, one can say that any stressful stimuli which are received by the cerebral cortex ultimately lead to some integrated physiological responses of the whole body. However, it was not at all clear as to how such a stress could produce many of the pathological lesions. It is here that our recent study of neurohumors greatly helped us to understand the pathogenesis of different stress disorders.

GENETIC FACTORS

It has been stated that all stress disorders are caused by multifactorial responses. Amongst them genetic factor is the most important one. It is known that some sort of susceptibility to get a particular disease such as diabetes mellitus, hypertension or coronary artery disease runs in families for several generations. How such a susceptibility is transmitted from parents to children is still a matter of conjecture. After studying the catecholamine degrading enzyme Monoamine Oxidase (MAO) in the platelets it is now postulated that the deficiency of this particular enzyme in the body might predispose a person to have a prolonged and excessive action of catecholamines leading to many harmful effects. Similarly, the deficiency of the acetylcholine degrading enzyme cholinestarases may lead to the harmful effect of excessive action of acetylcholine in different organs and tissues. Although all these matters need

further study and confirmation, one can certainly understand how possibly the genetic factors play their role in causing various disorders of stress.

In addition, the psychosomatic constitution of an individual can also become a genetically transmitted trait which can also predispose a person to certain stress disorders. Physical anthropologists have divided human physiques into three broad categories: Ectomorphs, Mesomorphs and Endomorphs. We have in our earlier studies observed that even the physical body constitutions have a neurohumoral basis and their susceptibility to certain diseases also has a biochemical explanation.

Similarly, psychologists have also observed that there are mainly two types of personalities which are genetically transmitted, Introverts and Extroverts. It was also noted that introverts were more susceptible to stress disorders than extroverts. Friedman and his colleagues divided personalities into two types, A and B. Type A personalities are more ambitious, hard working and restless. They are more liable to get stress disease than the others (Type B) who are relatively quiet, contented and satisfied with whatever they attain in their lives without much struggle.

It seems that all these genetically transmitted psychic and psychosomatic constitutions also have a neurohumoral basis and hence the subsequent development of different stress disorders also has a certain neurohumoral pattern.

ENVIRONMENTAL FACTORS

In addition to the genetic susceptibilities, various environmental factors such as age, sex, marital status, family circumstances, childhood experiences, dietetic factors, nature and amount of daily work load, etc. may also play an important role in the causation of stress disorders. Normally, any type of stress and strain would lead to a series of changes in the body so as to make the person adapt himself efficiently to the changed environment. It is in the process of adaptation that various nonspecific changes described by Selye, namely alarm reac-

tion, stage of resistance and stage of recovery or exhaustion take place. If proper adaptation leading to full recovery does not take place, the person goes into a stage of exhaustion leading to the development of one of the diseases of adaptation or stress disorder.

There has been considerable discussion as to whether there is any relationship between the types of stressful situation and the nature of disease process. For example, breakdown of love affair in girls would lead to thyrotoxicosis, too much of frustration in life would lead to peptic ulcer or excessive marital tension or worry in life would lead to hypertension etc. However, recent studies have indicated that no such correlations can be established between the nature of stress and development of a particular type of disease.

STAGES OF DISEASE

It has now been observed that once a favorable stage has been set in for the development of a stress disease, a series of neurohumoral changes takes place leading at first to psychic changes, and then to psychosomatic changes, followed by somatic changes before it settles down to any one of the susceptible organs. Here, in the organ also at first the functional changes occur followed gradually by organic changes leading to the development of disease in the form known to modern pathology. It is now well established that these pathological changes occur as a result of disturbances in the microcirculation in that organ caused by local neurohumoral disturbance. This is especially so with regard to catecholamines leading to excessive vasoconstriction for a prolonged period which would trigger off the development of autoimmune phenomenon in that organ. This usually gives rise to variable amount of chronic inflammatory process in that organ as we see in thyrotoxicosis which ultimately heals by fibrosis in favourable circumstances. On the other hand, if the circumstances are adverse, there is a breakdown of inflammatory process causing ulceration such as we see in peptic ulcer, which may deteriorate further causing haemorrhage or perforation or it may heal up if circumstances are found favourable.

From these observations, one can understand how the changes in the microcirculation which occur as a result of local neurohumoral changes, can cause the entire pathological phenomenon in a given organ. In short it is these neuro-vascular changes occurring in a given organ which are responsible for the production of the diseases. These are primarily brought about by the effect of stress on the cerebral cortex especially its psychic centre. This psychic centre regulates these neuro-vascular changes in a given organ by arranging to liberate appropriate neurohumors such as acetylcholine, catecholamines, histamine etc. and transmitting them to that particular organ through limbic system, hypothalamus, and the autonomic nervous system. Surprisingly, such unified theory for the causation of various disorders had been conceived centuries ago by the sages of ancient Indian medicine who postulated the presence of three humors for the production of various psychosomatic changes in health and disease. The importance of such unified neurohumoral theory is that it greatly helps to plan effective therapeutic measures from the point of view of prevention and also that of cure.

YOGA THERAPY

Apart from the various specific psychotropic drugs which may directly act on the cerebral cortex either to reduce the activity or to increase it, there is one method whose sole purpose is to restore the function of the cerebral cortex to normalcy either by reducing its activity or by enhancing it. That method is Yoga which was well conceived and described by ancient Indian authors about 2500 years ago and which proves to be of great value even today. Its unique contribution is that it directly affects the brain, especially the psychic centre from where all the psychosomatic stress disorders are initiated. Hence, one can say that the practice of yoga can be a specific measure for the prevention and control of stress diseases.

Our studies have enabled us to demonstrate that these yogic measures produce their expected beneficial results by directly acting on the production of neurohumors. Hence, it seems that it is one of the most efficient and scientific methods for the

management of stress diseases. It is this fact which made us study this problem in great detail and we are happy that not only we could establish a therapeutic regimen for all the stress diseases on scientific lines, but also could advance adequate scientific explanations for all the phenomenon that occur in the disorders of stress. We, therefore, initiated our studies both in experimental animals and clinical cases with stress disorders. It is the results of these studies which have become the basis of this monograph wherein yoga exercises are discussed in detail for the benefit of all those interested in this field.

CHAPTER 1

Historical Background

Humoral Theory in Ancient Indian Medicine

The Ancient Indian Medicine—Ayurveda is considered to be the Science of Life by ancient Indian authors. According to them it stands for a total concept of life which includes both man and his environment. It emphasises that the well-being of man does not consist in the maintenance of good physical health alone, but also includes the mental and spiritual health.

Life is never static; it continuously undergoes changes to adapt itself to the environmental changes. Such a continuous activity of the body and its psychosomatic constitution is brought about by three essential humors of life known as Vata, Pitta and Kapha. Amongst them, Vata seems to be closely related to central nervous system and is the most important humor which moves fast and controls the other two humors. Pitta resembles the sympathetic nervous system and Kapha to the histamine and its derivatives such as kinin. Thus, life is more dependent upon Vata than anything else in the body. It helps to receive message from the environment and then transmit it to different centres of brain and to other parts of the body, whereas, the other two humors become disturbed after the Vata has become deranged.

If the organism fails to adjust or adapt to the environment, it succumbs to disease. But, it has been observed that reaction to same type of adverse environment differs from individual to individual. This is because of differences in body constitutions inherited genetically. Therefore the changes in the environment and differences in body constitution both should be considered jointly in assessing the life of an individual.

PSYCHOSOMATIC CONSTITUTION

Such a constitution is inherited genetically by every person and it remains constant throughout his life. In each individual one of the humors i.e. Vata, Pitta or Kapha predominates. In some cases a combination of any two may predominate whereas in others all the three humors may become equilibrated.

People with Vata predominance have small thin bodies and are always restless. They usually talk much and undertake every work very quickly. They are quickly affected by fears, likes and dislikes. They are intolerant of cold. They have rough hair on the head and face. Persons with Pitta constitution are intolerant of heat and have excessive hunger and thirst. They usually have scanty soft hair and are liable to become bald at an early age. They are highly intelligent and active in their life. Persons with Kapha constitution have a pleasant well knit body. They are slow in action and speech. They are slow in undertaking any work. They usually have comparatively less hunger and thirst. They have very soft hair which remains black for a considerably long time.

THE ENVIRONMENTAL CHANGES

If all the environmental factors remained homogeneous and congenial to an individual, he would maintain a good physical, mental and spiritual health. However, if there occurs some erroneous, inadequate or excessive interaction between sense objects, senses, body and mind, then gradually the humors become vitiated and diseases set in such a body. The vitiating factors can be climatic change, misuse of sense organs or unfavourable psychological environments.

In case these changes are mild and of a short duration, there occurs only a slight imbalance of the body humors which gradually subsides and then regains its normal state. However, if the vitiating factors are strong and extend over a longer period, then one may contract any one of the following pathological states, depending upon the strength of etiological factors, power of the bodily humors and the results of their interactions. Thus,

(i) The vitiating process may spread and affect the entire body which offers no resistance. It may lead to acute generalised disorder.

(ii) The vitiating process may be strong, but the bodily response also may become equally strong and this will result in a prolonged interaction of waxing and waning. The ultimate result depends upon which side wins the struggle.

(iii) In some situations the vitiating process does not affect the whole body but becomes localized to some system, organ or tissue. Here again, the vitiating process spreads quickly, but the body tissue tries to localize it leading to the development of acute inflammatory response.

(iv) If the vitiating process is slow and the body resistance is strong, a chronic inflammatory response develops. Sushruta described six definite stages of this vitiating process. These are nothing but pathological changes in the humoral functions and are as follows:

1. Excess accumulation of humors at their own sites of production.
2. Provocation or peridodical spillover of humors into circulation.
3. Diffusion of excess humors into the whole body through blood.
4. Localization of humoral disturbances in a particular organ or tissue.
5. Manifestation of such localized disturbances.
6. Termination of the humoral disturbances by different types of sequelae.

1. Stage of excess accumulation

At this stage, there occurs an excessive accumulation of humors and also of the different materials required for producing more humors at their own place. The symptomatology of this state includes lethargy, low grade temperature, digestive

disturbances, irritability, nervousness etc. If appropriate measures are taken at this stage these disturbances can be overcome without much difficulty.

2. Stage of provocation

The vitiated humors are poured out from the site of origin into blood periodically, and are then allowed to circulate in the whole body. Because of these excess humors circulating in the body there appear generalised symptoms of malaise, fever and restlessness.

3. Stage of diffusion

The excess humors circulating in the blood infiltrate and then try to settle down in all the organs and tissues of the body. However, if the vitiating factors are too strong then the whole body may be affected and a generlised disease may start manifesting. If the vitiating factors are not so strong and the body has developed a good resistance, the humor may continue to circulate in the blood till it settles at one place.

4. Stage of localization

The localization of the disease occurs in some organ or tissue by accumulation of the vitiating humors at the susceptible sites. Thus these circulating humors having attained some foot-hold in some organ, gradually get themselves fully established and start producing symptoms which are indicative not only of vitiated humors, but also of the disturbed function of that organ. These combined symptoms help in recognising the disease in its early stage.

5. Stage of manifestation

The disease fully manifests itself with all its clinical symptoms. It can be a generalised one, systemic one, or of one organ or limb, depending upon the location of the vitiated humors. This is the beginning of the organic manifestation of the disease, which can be generalized or localized depending upon the

susceptibility of the individual. Further, it can be acute or chronic depending upon the amount of vitiated humors circulating in blood.

6. Stage of termination

This stage is the end of the vitiating process of humors. In this, either the person completely recovers from illness or there occurs a dissolution of the affected part, if the vitiating process is too strong and the resistance of the organ is too poor. In dissolution, there can be suppuration or necrosis of the part leading to ulceration and elimination of the vitiated humors. When such elimination does not take place, a chronic inflammatory reaction may continue for a long time till it subsides either by medical or surgical measures.

The understanding of these different stages of pathogenesis may be of great value in the diagnosis of the disease in its prodromal stage and also in adopting prompt preventive and curative methods of management. Hence, it appears that the Ayurvedic concept of the development of diseases may help physicians to adopt various preventive measures against different individual diseases much more effectively than the modern methods. Therefore, it is high time that intensive studies are conducted to understand these problems more scientifically for quick adoption throughout the world.

Humoral Theory in Greek Medicine

Historically, there had been a good parallelism in the development of the Greek and Indian medicine probably because of the common origin of the Aryan people. It is said that in the early period one set of these Aryan people migrated to Indus valley to settle down in India and the other set went to Greece. Thus, in Greece and India scientific thinking and philosophical speculation started very early. Because of this, both Greeks and Indians acquired much more profound knowledge of medical sciences than the others. From Greek medicine, gradually modern Western medicine developed. However, in India, med-

icine gradually developed more along psychosomatic lines and treatment was conceived in terms of Yoga and other psychotherapeutic measures. Since both these systems, namely Greek and Indian, originated initially from the same culture, there are great similarities in various theories including the humoral theory of both systems. They flourished almost at the same time around 5th century B.C. The well known author of Greek medicine was Hippocrates and those of Indian medicine were Charaka and Sushruta.

In the Hippocratic medicine four humors were described: their balance meant good health and their imbalance caused disease. These humors were phlegm, blood, bile and water. These are transmitted from parents to offsprings through the sperms and ova; hence children have the same humors as their parents. During life, these humors are continuously renewed and maintained properly from the food and drink that we take every day. A surplus or deficiency of any one of these humors may be the cause of physical or mental disturbances. In fact, excess accumulation of any of these humors was thought to be one of the main causes of the development of disease at that time. The disturbed atmospheric condition was considered as another cause and physical and emotional injuries as still other causes of disease. All these factors were believed to act on the bodily humors to make them vitiated. Such vitiated humors were supposed to travel in the whole body and then ultimately attach themselves to some part or organ of the body, and the resulting disease was named after the organ affected.

In the Hippocratic theory, these four cardinal humors were held responsible not only for producing diseases, but also were thought to be the normal constituent parts of the human system. Such a humoral theory was commonly accepted and it dominated the Western medical science for many centuries.

At that time it was known that many diseases had seasonal characters and for this, different behaviour of the humors in different seasons was thought to be responsible. Similarly, other variations in the human constitution such as tallness and shortness, leanness and fatness, intelligence and stupidity etc. were also considered as predisposing factors. It was also

observed that certain bodily qualities were frequently associated with definite mental qualities. Thus, fatty people are usually benevolent. The devil is pictured as lean. In short it was found that there were different types of psychosomatic constitutions of men. Every individual is unique and no two have the same finger print. Therefore, different people can react quite differently to the same stimulus. This is because of the fact that in each individual one of the humors predominates over the others.

Hippocrates also emphasized that each disease has a natural course. Thus common cold lasts for one week, Pneumonia for ten days and Typhoid for 3 weeks. This was because of the fact that it took so much time to discharge and excrete the vitiated humors from the site of lesion such as nose, bronchi or small bowel respectively. As already stated, to start with, it is usually one of the humors which goes out of order due to faulty diet or other ways of life. Unless the vitiated humor is eliminated fully and brought in balance with others, health cannot be restored to normalcy. Summarizing all these views, Segerist says, "In every case the disease was due to an upset balance of the constitutional elements of the body, such as for instance the humors and the humors were everywhere in the body. This explained why in every case of illness the whole individual was sick and not just one of his organs, although the faulty humor frequently attached itself to an organ or region of the body. Treatment, therefore, was to be not only local, but also general, and the importance of psychological element in every case of illness not overlooked".

From the above it becomes clear that there was a close similarity between the views of ancient Greek physicians and the ancient physicians of India during the fifth century B.C. Both the groups believed in the humors dominating the body constitution and then becoming responsible for causing disease. Both held that these humors became vitiated due to a variety of external or internal causes in the entire body at first and then settled down in one of the organs or regions of the body. Disease is cured only when the vitiated humor is eliminated either in a natural way or by medical treatment. The only

difference between Greek and Indian medicine was that the Greek physicians recognized four humors, including blood as the fourth one, whereas, ancient Indian physicians recognized only three humors. The details of the humoral theories of ancient Indian physicians have already been given. Suffice it to say here that there existed a close similarity between the humoral theories of diseases described by the ancient authors both Greek and Indian and the present day neurohumoral theories. Therefore, what the ancient physicians have described by their clinical observations can be confirmed now by the present day laboratory investigations. There is a great need for studying the ancient treatises written 2500 years ago for a better understanding of the entire problem.

Evolution of Humoral Theory in Medical Sciences

The concept of control of body functions by humors prevailed well over two thousand five hundred years. In fact from the time of Hippocrates (460-370 B.C.), Aristotle (384-322 B.C.) and Galen (130-200 A.D.) the humoral theory played a dominant role until the early part of the 19th century. In the 16th and 17th centuries this theory was questioned seriously, but there was nothing to replace it. The discovery of bioelectricity by Galvani in 1792 showed that during muscle contraction there occurred a flow of electric current sufficient to excite adjacent tissues. This led to the development of new ideas. Then the people thought that the transmission of excitation and control of body function were dependent upon the electrical rather than humoral phenomenon. From then onwards until the middle of the 20th century, there accumulated a large amount of data to show that predominantly it was the electrical process that controlled the function of nervous system and the activities of peripheral organs. Before the discovery of bioelectricity humors were thought to be responsible for causing muscle contractions and also for producing emotional and behavioural changes. At that time it was felt that nerves were involved in the transport of these humors to the target organs or tissues. Now when it was realized that nerves were not tubes

through which fluids might flow as does blood in the artery, the entire humoral concept receded into the background and it gave way to the more recent theory of electrical conduction controlling every organic function. The theory of electrical energy as the only source of excitation of organs and tissues remained in vogue for about two centuries. However, towards the middle of this century it became apparent by various studies that different chemical agents are required for conducting the excitation from neuron to neuron and from neuron to various target organs and tissues. As a result, the humoral or neurohumoral theory regained its importance in the regulation of the entire body function. Although electrical processes are even now thought to play some important role, they are no longer considered as primary factors in body functions.

However, it should be noted that current ideas about the nature of humors or neurohumoral agents released from the nerve endings appear to be somewhat different from the ancient ones, though, in principle, they can be easily compared with each other. It is now well known that the proof for the existence of chemical mediation and neural control of smooth and skeletal muscles was put forward only during the last four decades or so. Earlier it was thought that some such chemical mediation existed, but its exact nature could be determined only recently. Thus, the chemical transmission of nerve impulses to the affected cells can certainly be called a humoral agent controlling body function. Amongst all the humors, acetylcholine which is liberated by most of the cells of the central nervous system seems to be the most important primary humoral agent. The other neurohumoral agents will be discussed later on. Release of many hormones is triggered as a result of stimulation of these neurohumors. These hormones, therefore, can also influence the turnover of the neurohumors to a certain extent. However, it is primarily the brain which controls all the body activities by liberating various neurohumors directly and also indirectly by activating the autonomic nerves and the neuro-endocrine apparatus. Most of these changes are adaptive in nature. These adaptive changes occur

to maintain a constancy of body states which is known as 'homeostasis'. Which neurohumor initiates action in the brain is the subject of some controversy. It is agreed by many neurophysiologists that acetylcholine is the principal mediator of central synaptic transmission. However, they feel that there are other neurohumors, especially the aminoacids which not only initiate the action, but also modify the excitability of these nerve cells. All these cells synthetize the neurohumors and transmit them through their axons till they reach the junction of the target cells. Then, they are stored as quanta in case of acetylcholine or vesicles in the case of catecholamines and are released whenever a stimulus reaches the site. This in brief is the present concept regarding functions of neurohumors.

CHAPTER 2

The Brain and its Subcortical Centres

In the West there were initially two parallel theories, one proposed by Pavlov asserting the higher nervous activity of the cerebral cortex and and the other by Langley asserting the dominance of autonomic nervous system. These theories were of considerable significance in preventive and curative clinical medicine. However, later on these two theories were merged as it was observed that under certain special circumstances the cerebral cortex could modify the activity of the autonomic nervous system including functions of the heart, lungs, stomach and intestines. Thus, it could ultimately be asserted that all the functions of the body systems including those regulated by the autonomic nervous system are under the authority of the higher division of the central nervous system. It was found that all the internal organs and the blood vessels which supply them are richly supplied with various receptors such as Chemo-, Thermo- or Osmo-receptors which directly connect these organs with the sensory apparatus of the brain. When the brain receives excessive stimuli, it may undergo various changes leading to the development of neurosis, which in turn produce changes in the autonomic nervous system and the viscera supplied by it to produce psychosomatic disorders. Thus, the development of neurosis appears to be a precondition for the initiation of psychosomatic disorders and the clinician must remember this fact while managing these cases. Therefore, let us now discuss the various mechanisms involved in cortico-subcortical interrelationships.

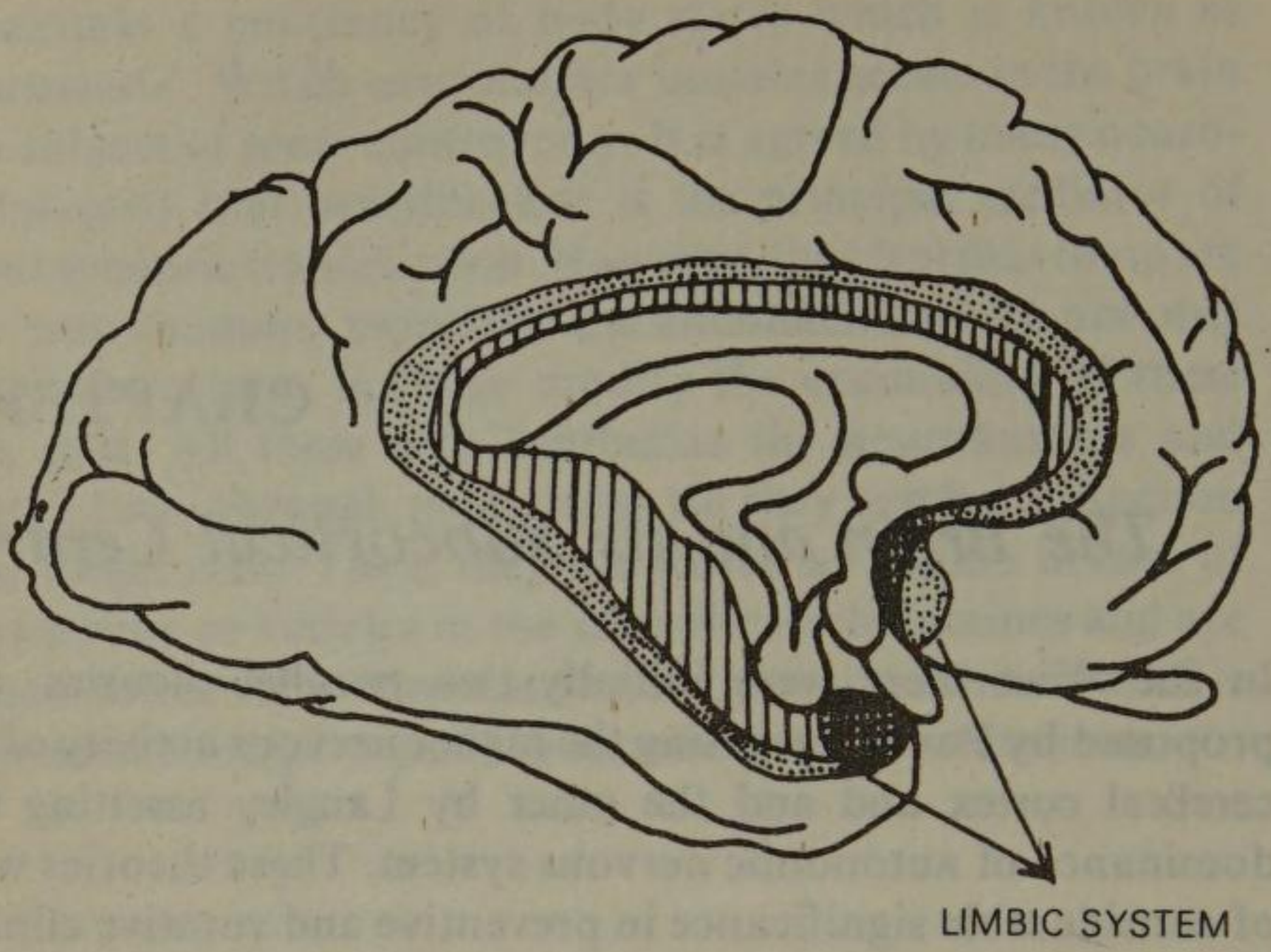


Fig. 1. Shows the area of the brain comprising the limbic system.

Limbic System:

It is now well established that the limbic system is deeply involved in the behavioural, emotional and olfactory reactions of the body and also in the regulation of autonomic visceral activity. It mainly consists of cyngulate gyrus, orbital areas of cerebral cortex, the hippocampus, amygdaloid nucleus, olfactory bulb, fornix, thalamus and hypothalamus (Fig. 1). Why such heterogeneous structures are grouped together as limbic system is because they help to maintain the homeostasis or constancy of internal environment of the organism, and play an important part in the formation of emotional and behavioural reactions. Thus, any excitation of the limbic system would produce behavioural and emotional reactions leading to changes in the cardiovascular, respiratory and digestive systems. In addition, significant endocrine changes are also observed particularly in the pituitary and adrenals, the hormones of which play an important part in the reaction to stress. Besides this, there is striapallidial system which plays most intimate and active part in the cortico-subcortical integration.

It consists of two corpora straita, the caudate nucleus and lenticular nucleus. Its main function seems to be inhibiting the autonomic and visceral activity probably mediated through the cholinergic and adrenergic innervations.

The thalamus also plays an important part since it is the main subcortical sensory centre in which almost all the afferent pathways of the cerebral cortex terminate. Through these pathways only, the thalamus is connected with all parts of the cerebral cortex. The thalamus is also well connected with the frontal lobe (psychic centre) both by afferent and efferent pathways.

The Reticular formation

The cerebral cortex is also connected with various subcortical centres by diffuse projection system called ascending reticular formation. They connect the cortex with reticular nuclei of

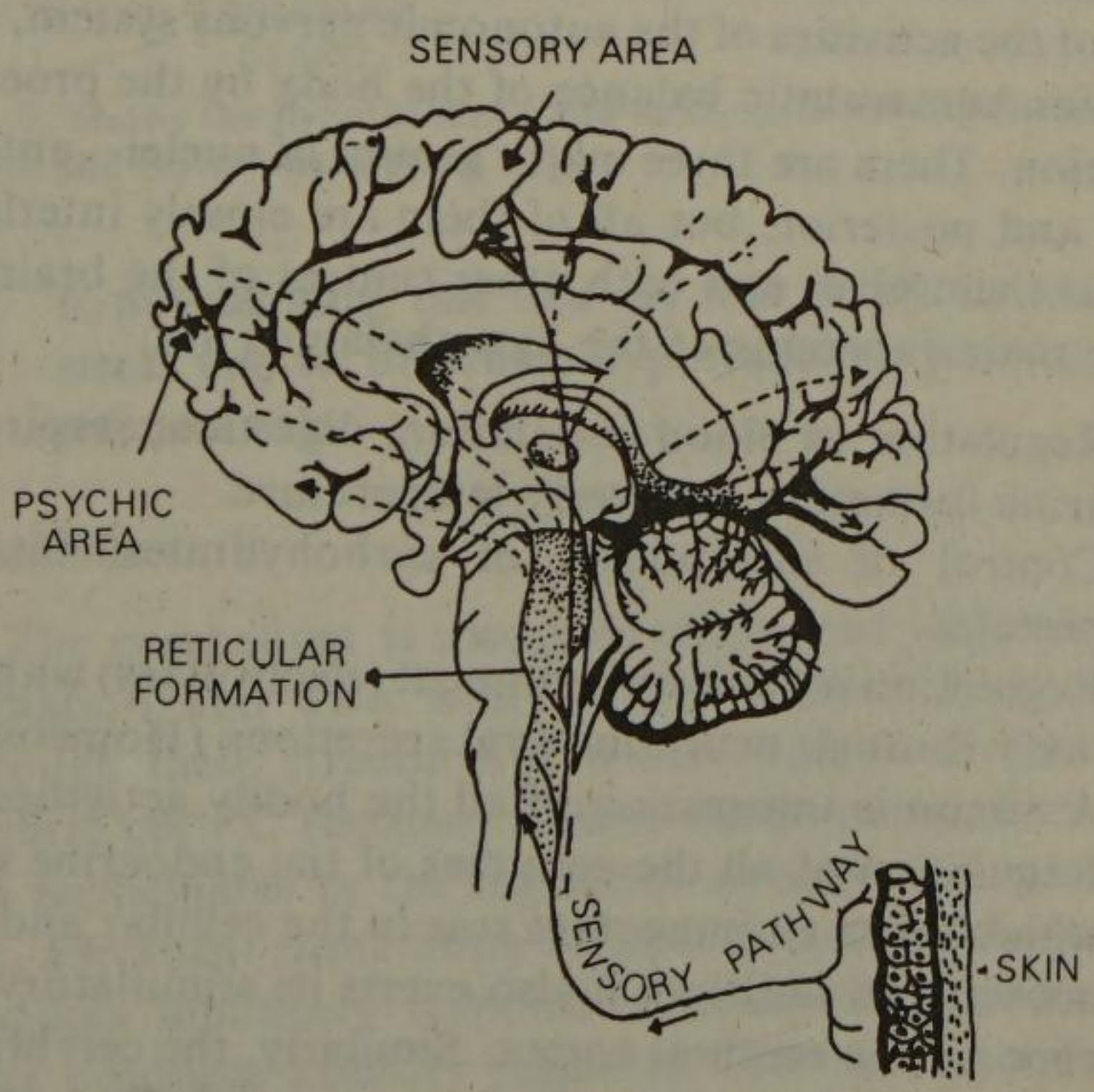


Fig. 2. Shows the reticular formation and their connection showing sensory pathway below and various centres of cerebral cortex above.

medulla oblongata, pons, hypothalamus and the reticular nuclei of the thalamus. These connections have a diffuse activating influence over the cerebral cortex (Fig. 2). On the other hand, these connections also enable the cerebral cortex to regulate the activity of the autonomic nervous system. Since the reticular formation system receives multiple collaterals from all the specific regions of the brain, it plays an important part in the integration of various activities of the cerebral cortex.

Hypothalamus

The hypothalamus plays a central role in controlling the activities of various internal organs. It is closely connected with the structures of cerebral cortex, thalamus, limbic system and the brain stem and in that manner it acts as a rail road junction (Fig. 3). Through this the brain regulates the autonomic, endocrinal and metabolic functions. In fact, it is the highest centre of the activities of the autonomic nervous system, and it maintains homeostatic balance of the body by the process of adaptation. There are three major groups of nuclei—anterior, medial and posterior, but all of them are closely interlinked amongst themselves and with other centres of the brain.

The main functions of the hypothalamus are:

1. Regulation of blood circulation, digestion, respiration, urine formation and body temperature.
2. Control of metabolism of carbohydrates, fats and protein.
3. Regulation of ionic environment (electrolytes) within the body through neurohumoral secretions (Homeostasis).
4. Autonomic integration of all the bodily activities.
5. Regulation of all the activities of the endocrine system which plays an important role in the cellular and tissue activity. In addition, it also exerts its stimulatory influence on the cerebral cortex. Similarly, the cerebral cortex, especially the frontal lobe, exerts its influence on the hypothalamus directly and also through the limbic system. Considering the above mentioned functions of

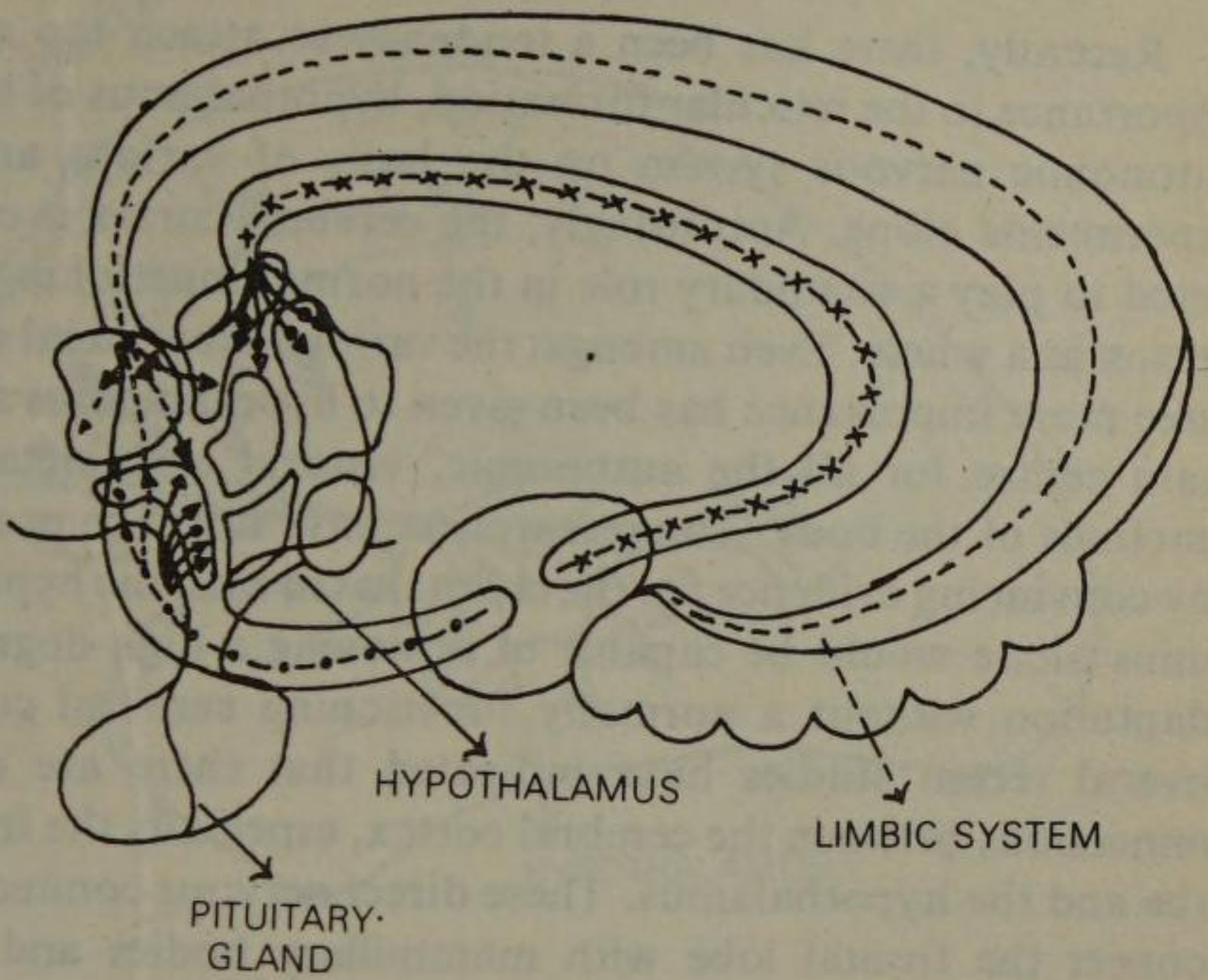


Fig. 3. Shows the hypothalamus and its connection with the limbic system above and the pituitary gland below.

hypothalamus, one can say that in all the problems of stress and its disorders hypothalamus plays a most significant role.

Cerebellum

The cerebellum is also well connected with the reticular formation and also with various nuclei in the thalamus. Through these structures it is also well connected with the cerebral cortex. Because of these connections, the cerebellum also participates in the regulation of autonomic nervous system. Electrical stimulation of certain areas of the cerebellum produces inhibitory response whereas stimulation of other areas produces excitory response. All these stimulations are transmitted to autonomic nerves and viscera through the cerebral cortex and its limbic system.

Interaction of Cerebral Cortex with Subcortical Structures

CORTEX AND HYPOTHALAMUS

Recently, there has been a tendency to attach too much importance to the reticular formation, hypothalamus or to the autonomic nervous system on the basis of various animal experiments alone. Accordingly, the cerebral cortex is considered to play a secondary role in the normal functioning of a person as a whole. Even amongst the various subcortical structures more importance has been given to hypothalamus as the main centre for all the autonomic, visceral and metabolic functions of the body. The researchers have failed to produce any convincing evidence for the claim that in man the hypothalamus alone would be capable of achieving a high degree of adaptation without a normally functioning cerebral cortex. Several recent studies have indicated that there are direct connections between the cerebral cortex, especially the frontal lobe and the hypothalamus. These direct nervous connections connect the frontal lobe with mammillary bodies and also lateral and posterior hypothalamus (Fig. 4). Further, there are also projections from certain areas of frontal and orbital lobe to the supraoptic and and paraventricular nuclei of the hypothalamus. Most of these connections between the cerebral cortex and the hypothalamus are two way and bilateral. Moreover, such nervous connections are not only confined to direct pathways. There are also indirect functional connections between the cerebral cortex and the hypothalamus through various subcortical structures especially the thalamus in the form of cortico-thalamic and thalamohypothalamic fibres. Apart from this, there is physiological evidence to show that hypothalamic centres regulating autonomic activity are under the direct control of the cerebral cortex. For example, the frontal lobe exerts an inhibitory effect on the hypothalamic excitation of the salivary and gastric secretions. Such inhibitory influences of the cortex are blocked by various emotional excitements which ultimately lead to intensification of the autonomic reactions of the hypothalamus. Thus, the cerebral cortex makes an extensive use of the hypothalamus in order to

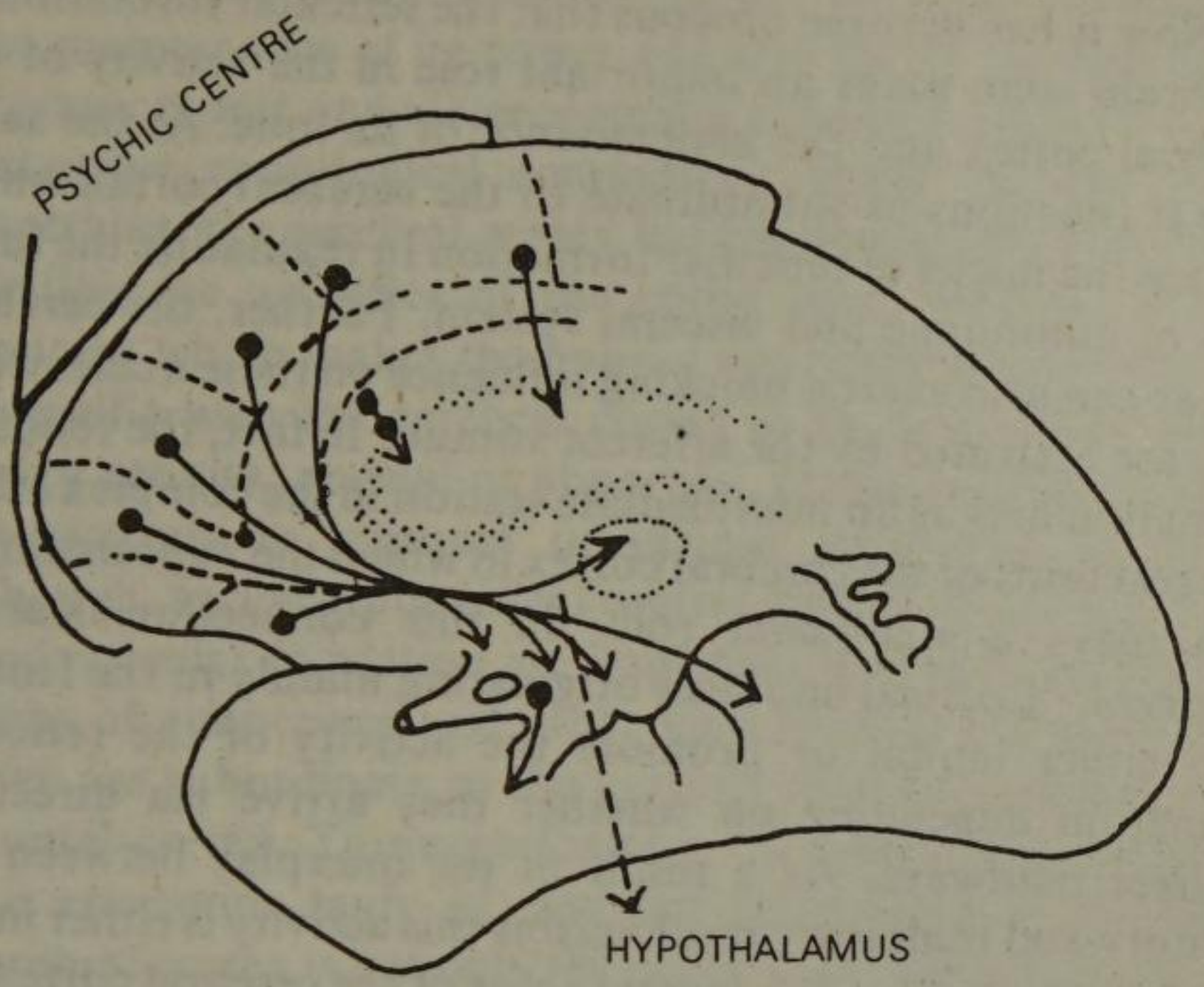


Fig. 4. Shows the connecting nerve fibres from the psychic centre of the frontal lobe to the hypothalamus below.

regulate the functions of internal organs, endocrine glands and also emotional reactions. Apart from this, the cerebral cortex, especially the frontal lobe, also exerts an inhibitory influence on the hypothalamus and through it on various behavioural reactions. In this regard, Kurtsin states, "Thus, in our opinion all claims that the hypothalamus is independent of cortical influence and plays the leading role in the control of autonomic visceral activity are unfounded since it has been shown that though the hypothalamus centres are very important biologically, in higher animals and man they are regulated, co-ordinated and generally controlled by the higher cerebral centres at the level of the cerebral cortex." From this one can say that the hypothalamus is an important part of the cortico-limbic, reticular hypothalamic complex which helps to adapt the autonomic and visceral functions in response to some external and internal environmental stimuli.

CORTEX AND RETICULAR FORMATION

Now it has become obvious that the reticular formation of the brain stem plays an important role in the activity of the cerebral cortex and the maintenance of its tone. At the same time it functions as subordinate to the cerebral cortex which utilizes the nuclei of reticular formation in regulating the function of autonomic and visceral system. Further, the cerebral cortex can also exert a blocking influence on these nuclei when they are activated by the afferent stimuli. In fact, the reticular formation acts as an intermediate station in the complex adaptive reactions of the cerebral cortex in which the hypothalamus also plays a significant role. In this connection Kurtsin observes, "Cortical impulses originating mainly in the frontal area either inhibit or promote the activity of the reticular formation depending on whether they arrive via direct or indirect pathways. As a result of the interplay between the excitory and inhibitory mechanisms this activity is either intensified or blocked.... The frontal areas of the cerebral cortex are thought by some to play the decisive part in the integration of both behavioural acts and autonomic reactions. It is they which are able to inhibit the subcortical neural structures down to and including the reticular formation as well as the spinal conducting paths and autonomic centres". Further, he continues, "At the same time the reticular formation generates new bio-potentials which did not previously exist, indicating inhibition of the pathways conducting visceral impulses which do not function when the cortico-reticular connections are intact. In man this activating function of the reticular formation is dependent on influences from the limbic area of the cerebral cortex".

It is said that from the limbic cortex the efferent pathways also proceed to the anterior hypothalamus via supra-optic and paraventricular nuclei and mammillary bodies. From here these fibres continue through nuclei in the medulla oblongata and then through the vagus and sympathetic nerves into various affected organs such as heart, stomach etc. In short the reticular formation, like all other subcortical centres, is func-

tionally subordinate to the cerebral cortex and the cortical centres utilize the reticular formation whenever necessary for the maintenance of its power and also for its connection with the autonomic and viscerosomatic activities. Because of these extensive neurological connections which regulate various functions, the cerebral cortex has the unique position for integrating the activities of the entire body systems. It is this concept which makes the holistic approach of medicine really scientific with the cerebral cortex at its apex which initiates every activity, normal or abnormal, during health and disease respectively in response to various environmental stimuli. Though, various subcortical centres such as the hypothalamus and reticular formation are important for regulating the functions of endocrines and other vital organs, in human beings they are subordinate to the cortical centres, especially to the frontal cortex. To quote Kurtsin, "It means that one ignores the enormous body of evidence testifying that the human cerebral cortex is not only the organ of mental activity but also the supreme nervous centre for analysis and synthesis which integrates, coordinates and regulates the condition and activity of all the internal organs, endocrine glands, and blood vessels and somatic autonomic activity". In the same vein Kurtsin observes: "This is why it is impossible to agree with those who assign the cerebral cortex a secondary, auxiliary role in the mechanism of integration and control of autonomic visceral activity and in the regulation of such biological states as thirst, hunger and libido. While this point emphasized the dominant role of the cerebral cortex in the central mechanisms regulating autonomic visceral activity, it by no means detracts from the importance of the subcortical stem formations which constitute a 'functional unit' of the cerebral cortex". From this it becomes clear that the cerebral cortex has the pre-eminent position in all the activities of the body during health and disease with various subcortical centres as the functionally independent units which work under the overall control of the cerebral cortex. These facts are of great significance for the Indian science of Yoga which is stated to improve the power of the cerebral cortex in order to have a control over the auto-

nomic and visceral functions of the body. Thus, it seems, "Yoga" helps to develop better integration of various cerebral centres with the subcortical autonomic centres. It is the development of this vital power which ultimately makes a better man in the evolutionary sense since he would be able to control all the activities of the body by his sheer will power which would enable him to live a longer and happier life than what it is at present.

RELATIONSHIP OF CEREBRAL CORTEX WITH INTERNAL ORGANS

In the evolutionary process, the neocortex consisting of the cerebral cortex does not actually replace the ancient and older structures of the brain, such as brain stem centres. In fact, cerebral cortex only co-exists with them, though acquiring functionally a more dominant position. Thus, the brain stem portion which from the view point of evolution is an ancient part of the brain, has direct connections with all the internal organs through medulla oblongata and spinal cord. But the most advanced and developed part of the brain, namely the cerebral cortex, does not have a direct connection with internal organs and it makes its contact with these organs only through various subcortical structures. The cerebral cortex is a highly developed structure, yet highly integrated. In higher mammals it becomes the most dominant part of the brain and it is endowed with higher mental functions. It takes over the function of all the earlier parts of the brain seen in lower animals by integrating, coordinating and regulating the functions of the central nervous system, and also of the autonomic nervous system which were previously carried out in a primitive manner by the lower cerebral centres.

Developmentally also, in the early stages of postnatal life, only the subcortical connections, such as thalamic and hypothalamic connections, are found in the first few weeks. The cortico-pyramidal connections and the cortico-extrapyramidal connection develop only after 4th to 6th month. The verbal connections develop still later. Gradually as the age advances the cerebral cortex acting through the subcortical

and other lower centres integrates the entire external and internal activity of the body and brings it into equilibrium with the external environment, thus providing optimum conditions for existence.

Thus, it is obvious that the cerebral cortex has a regulatory influence on the function of all the internal organs. These regulatory influences of the cerebral cortex do not occur by direct neural connections between the cortex and these organs. But it regulates the functions of internal organs by various neural and humoral chain reactions. Such reactions include numerous short and long reflex arcs, feedback systems, hormonal influences and metabolic interactions. Thus the cortico-visceral response occurs as a result of external or internal stimuli by both direct and indirect means of communication. The influence of the cerebral cortex on the subcortical centres and thereby on the internal organs can be stimulatory or inhibitory. An inhibitory response in the central nervous system occurs as a result of an excessive production of gamma-aminobutyric acid, which is the inhibitory mediator. This substance when formed causes a blocking reaction on the post-synaptic membrance and raises the excitation threshold leading to inhibitory response. Thus the ultimate effect is the result of a highly complex cortical-subcortical integration in which a significant part is played not only by the stimulatory mechanisms, but also by the inhibitory mechanisms of the cerebral cortex which are conveyed to the internal organs through various means.

What are the means through which the cerebral cortex controls the functions of internal organs? A large number of studies have indicated that the means could be direct or indirect. In the direct control, the cortical excitation is transmitted through one neuron to the other through the mediators like acetylcholine or noradrenaline, and from the terminal neuron to the affected cell which is further influenced by the second messenger in the cell membrance, namely, cyclic AMP or GMP.

The indirect control of the cerebral cortex over the functions of internal organs can be through the autonomic ner-

vous system which would influence the vascular system by way of vasodilatation or vasoconstriction. Through such a mechanism, vasodilatation would influence the capillary permeability and thereby the osmotic properties of blood. In this way it can influence the formation of hormones and their passage into blood. In the same way the vascular response influences many other cellular activities, such as tissue respiration, absorption and elimination of nutritional products, production and secretion of various hormonal substances. Therefore, the influence of the cerebral cortex not only produces stimulation and inhibition of internal organs, but also actively takes part in the cell metabolism and other cellular activities including permeability of cell and subcellular membranes and also other activities of various cellular enzyme systems.

One of the main functions of all these controlling systems is to maintain the constancy of internal environment, which is mostly done by the autonomic nervous system under the overall control of the cerebral cortex (Fig. 5). Any deviation in the normal internal environment is automatically followed by stimulation of the controlling system regulated by the nervous and humoral feedback mechanism. This immediately activates the neural integrator, namely, autonomic nervous system and also the humoral integrator, the endocrine glands to produce defence—adaptation response which restores the normal activity of the cells, organs, and various systems of the body. Such a selfregulatory mechanism exists not only at the organ level, but also at the cellular, subcellular and possibly even at the molecular level as seen in tissue culture studies. Even then in the intact animals, all these activities are regulated by the cerebral cortex as discussed earlier. In this connection Kurtsin states, "At the level of man and higher animals the central controlling organ is the cerebral cortex and the adjacent subcortex which through the main 'switch board' represented by the limbic system, the thalamohypothalamic region and the reticular formation exert their regulatory influence on the 'nervous' and 'humoral' integrators and

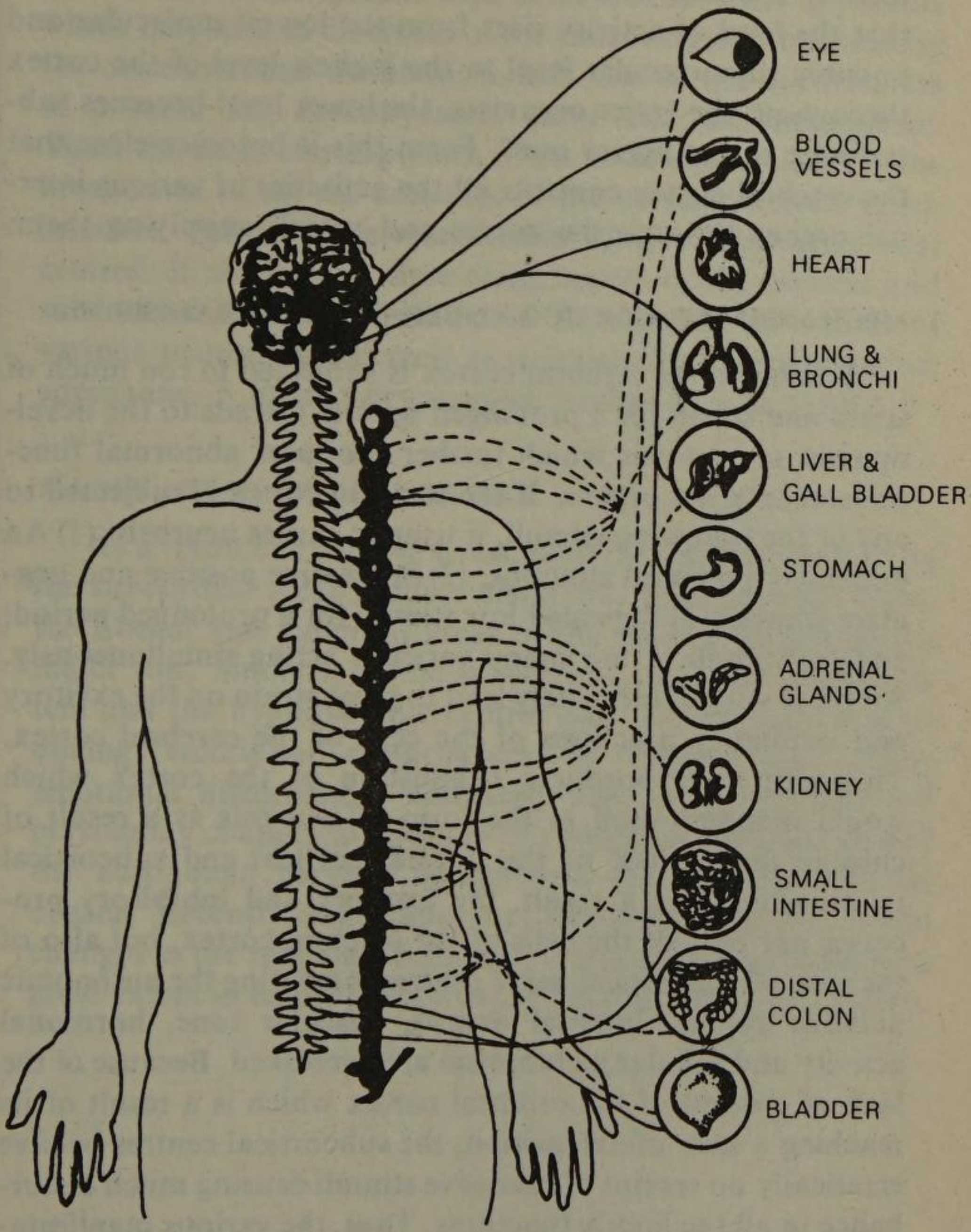


Fig. 5. Shows the sympathetic and parasympathetic nerve connections to different organs.

through them on all the autonomic processes in the cells and tissues. It seems that one must also recognize the principle that the level of activity rises from the lowest molecular and possibly submolecular level to the highest level of the cortex throughout the entire organism, the lower level becomes subordinate to the higher one". From this it becomes clear that the cerebral cortex controls all the activities of various internal organs through the nerves and vessels supplying them.

MECHANISM OF CORTICO-VISCERAL DISTURBANCES

Whenever the cerebral cortex is subjected to too much of stress and strain for a prolonged period, it leads to the development of neurosis which further produces abnormal functions of internal organs. If the cerebral cortex is subjected to any of the following stimuli, it usually causes neurosis: (1) An extremely powerful stimulus; (2) Successive positive and negative stimuli; (3) Repeated low stimuli for a prolonged period; and (4) Stimuli of too many varieties acting simultaneously. All these stimuli ultimately lead to great strain on the excitory and inhibitory processes of the cells of the cerebral cortex. This ultimately produces exhaustion of the cortex which would manifest itself in the form of neurosis as a result of chronic disturbance of the normal cortical and subcortical relationships. As a result, the excitory and inhibitory processes not only of the cells of the cerebral cortex, but also of the cells of subcortical nerve centres regulating the autonomic nervous system, internal organs, vascular tone, hormonal activity and cellular metabolism are overtaxed. Because of the lack of control of the cerebral cortex which is a result of its reaching a state of exhaustion, the subcortical centres behave erratically on receipt of excessive stimuli causing much disturbance in all the bodily functions. Thus, the various manifestations of psychogenic stress depend not only upon the amount of exhaustion of the cerebral cortex, but also upon the amount and depth of involvement of various subcortical structures in the neurotic process such as reticular formation, brain stem, thalamus, hypothalamus and cerebellum. Such a

disturbance does not remain confined to these subcortical centres alone but spreads also to neuroendocrine apparatus which may lead to disorders of the endocrine glands including the catecholamine metabolism, and also to the disturbances of protein, fat, carbohydrate, water and salt metabolism. Thus, the main starting point of all these disturbances is the breakdown of all the activities of the cerebral cortex which interfere with its close relationship with various subcortical centres. It seems that these disturbances in the cortical and subcortical centres are mediated through the liberation of various neurohumors, such as acetylcholine, noradrenaline, adrenaline, 5 hydroxytryptamine, histamine and GABA.

MAJOR AREAS OF DISTURBANCE

As a result of excessive stress, both the cerebral cortex and the subcortical areas become disturbed. Even amongst them, the frontal and temporal areas of the cerebral cortex play a major role. Similarly in the subcortical areas, the limbic system and the hypothalamic centres play a major role in producing emotional disturbances in these cases. These emotional disturbances ultimately lead to behavioural and personality changes in addition to changes in the functions of the autonomic nervous system and the different internal organs. Recently importance has also been attached to the changes in the reticular formation which also contributes to a great extent in causing disturbances in the emotional pattern.

CHAPTER 3

Neurohumors

It is now well established that psychological and all other types of stress produce a series of neurohumoral changes leading to endocrinal, metabolic and other systemic changes. Therefore, a basic knowledge of neurohumors is essential to understand the whole problem.

The nerve cells have two important properties: (1) Electrical transmission, and (2) Chemical transmission. Both are very much interrelated and by assessing one, the other can be roughly quantitated. The nature of chemical transmission can be studied at the synaptic junction where the transmitters which are also known as neurohumors, are released by the presynaptic nerve terminals into the synaptic cleft and are then taken up by the post-synaptic cell membrane. Thus, whenever there is an excitory impulse at the presynaptic nerve terminal, there occurs a physical change in the state of the membranes which increases the permeability to small cations. After the receipt of the impulse, at first the affinity of the excitable cell membrane for calcium ions is decreased. This displacement of calcium ions causes a conformational change in the cell membrane which permits transiently the sodium ion to enter and the potassium to leave the cell. The excitory effects are usually attributed to a depolarization of the cell membrane produced by the inward movement of sodium. This transient change is restored to normalcy as soon as excitory impulse stops. On the other hand, increase in potassium causes acceleration of the rate of return to normalcy of the resting potential of all the depolarized membranes and would decrease the sensitivity of the membrane to stimulation. It is by these ion exchanges that the stimulation or inhibition of the neurohumors is brought into action at the synaptic cleft.

It is postulated that the bulk of neurotransmitter synthesis occurs in the presynaptic terminal. However, some of the transmitters may also be synthetized in the main body of the nerve cell in almost the same way as synthesis of protein occurs in all other functionary cells. These newly synthetized neurohumors are deposited in small vesicles which would then travel along the axons to their nerve terminals. Whenever the stimuli reach the nerve terminal, there occurs a fusion between the presynaptic membrane and the vesicles and the contents of the vesicles are extruded by exocytosis into the synaptic cleft filled with glycoprotein materials. This produces changes in the post-synaptic membrane of the receiving cell leading to the excitation of that cell. Soon the neurohumor is inactivated by the respective enzymes both in the synaptic cleft and also in the post-synaptic cell itself. However, some amount of neurohumor is reabsorbed and deposited in the presynaptic nerve endings. In addition, a small quantity may even leak into the extracellular space which is absorbed into blood capillaries present in the region.

After the secretion, each neurohumor binds to specific receptors on the post-synaptic membrane and produces its post-synaptic effect on the cell. In case of acetylcholine, the broken down choline may also be taken up by the neuron and resynthetized into acetylcholine. The nature of the post-synaptic activity may differ from one neurohumor to the other. Many of them, such as acetylcholine, catecholamines, etc. are excitory, whereas others, such as GABA (Gamma aminobutyric acid) or glycine may have inhibitory effect on the post-synaptic nerve cells. These are some of the general properties of neurohumors. Let us now discuss the characteristics of individual neurohumors briefly.

Acetylcholine

Recently, much work has been done on the role of acetylcholine in cholinergic transmission in the central nervous system. It is being studied extensively by using various chemical methods and by correlating these findings with the functional

disturbance of the brain. Acetylcholine is present in significant amount in all mammalian brains. However, it is not uniformly distributed within the brain. The highest concentration of acetylcholine is found in the caudate nucleus and the lowest in the cerebellum. There is normally a good correlation between the amounts of acetylcholine and its synthetizing enzyme "Choline acetylase" and its degrading enzyme "Cholinesterase" in any region of the brain.

The acetylcholine content of the brain does not remain constant. It varies inversely with the degree of functional activity of the brain. Thus, it remains normal or above normal during sleep or when the subjects are kept under anaesthesia. It is found considerably reduced during emotional excitement, electrical stimulation or during convulsions. This is because of the fact that during increased nervous activity or psychosomatic stress there occurs increased liberation of acetylcholine from the nerve endings of the brain followed by its destruction by cholinesterases.

METHODS OF MEASUREMENT

One of the most sensitive methods to measure acetylcholine in the tissues is the bioassay method in which frog's rectus abdominus muscle, dorsal wall of the leech, cat's blood pressure or guinea pig ileum are frequently used in a descending order as test objects. Some of these assays are most sensitive and under properly controlled conditions, the most specific procedure for determining acetylcholine. In recent years, many attempts have been made to devise various chemical methods with relatively higher sensitivity for determination of acetylcholine. Amongst them Radio-Isotopic, fluorometric and gas chromatographic methods have received more attention. For details of these techniques one may refer to the original papers of the authors.

METABOLISM OF BRAIN ACETYLCHOLINE

Synthesis:

Acetylcholine in the nervous system is synthetized from choline and acetylcoenzyme-A, which is catalysed by enzyme

choline acetylase in the following:

Choline+Acetyl-Co A-Choline Acetylase=

Acetylcholine+Co A.

The main sources of choline for synthesis of acetylcholine are (1) Dietary choline which reaches the brain through the blood, (2) Reuptake of free choline after the catabolism of acetylcholines, and (3) Phospholipids of the brain tissue. The choline received from each of these three sources can be used for the synthesis of acetylcholine. If radioactive C^{14} choline is injected intravenously into animals about half of the same is converted into C^{14} acetylcholine. Thus, there is a definite evidence to indicate that much of the dietary or injected choline is utilized for the formation of acetylcholine.

The main source of acetyl CoA for the synthesis of acetylcholine within the brain cell is the oxidative metabolism of glucose via pyruvate. The oxidative conversion of pyruvate to acetyl CoA takes place in mitochondria. From here it comes out at the nerve endings and acts on choline to form acetylcholine.

The properties of enzyme choline acetylase, which help in synthetizing acetylcholine have not yet been fully established. Its molecular weight is approximately 65000 and it is mostly attached to the cell membrane.

SYNAPTIC NERVE TERMINALS

Regulation

The regulation of acetylcholine synthesis occurs through negative feedback mechanism as it occurs in the case of other hormones. There is definitely a limit to accumulating acetylcholine in the brain beyond which it does not increase further. Thus, if acetylcholine is present in adequate quantity, no more of this neurohumor will be formed. Similarly, if excess of acetylcholine is released from the brain, more synthesis of acetylcholine would occur with the operation of feedback system.

Storage

It had been shown by Whittaker and his colleagues that most of the acetylcholine present in the brain can be recovered from the presynaptic portion of the nerve terminals called synaptosomes. In the synaptosome, acetylcholine can be isolated mostly from the synaptic vesicles, though it can also be isolated from other components such as cell cytoplasm membrane and mitochondria to a lesser extent. The studies conducted after injection of H^3 choline revealed that acetylcholine is synthetized in the cell cytoplasm and then eventually transferred to the vesicles which, thus, act as a storehouse for acetylcholine within the nerve endings.

Release

It is now well established that acetylcholine is released from the brain tissue in a large quantity whenever there is stimulation of the brain by excessive psychosomatic stress, electrical stimulation, or by the administration of certain psychotropic drugs. On receipt of any such stimulation, the vesicular acetylcholine is released as quanta through exocytosis. Thus, synaptic vesicles would fuse with the presynaptic membrane, open to the synaptic cleft and extrude their acetylcholine content outside the nerve terminals.

Enzymatic destruction

The most important means of inactivation of this neurohumor in the central nervous system is by hydrolysis of acetylcholine into choline and acetate by the enzyme cholinesterase. Acetylcholine + H_2O = choline + acetate. This enzyme is present in abundance and mainly attached to the particles of pre - and post-synaptic membranes. The regional distribution of cholinesterase in the brain is similar to that of acetylcholine and its synthetizing enzyme choline acetylase. The cerebellum is an exception where cholinesterase is found proportionately much more than the acetylcholine. The reason for such a change is not yet clear.

Reuptake

It is now well established that a part of the acetylcholine secreted into the synaptic cleft escapes the action of cholinesterase and is reabsorbed into the presynaptic nerve terminals. This process can be further aggravated by the administration of anticholinesterase drugs. It seems that this process of reuptake is another method of inactivating acetylcholine within the brain which works in addition to the action of cholinesterase in terminating its action.

Influence of Drugs

Various drugs may regulate the activities of this neurohumor, (1) by influencing the synthesis of acetylcholine by acting on the synthetizing enzyme or on choline, (2) by interfering with the release of the neurohumor, and (3) by interfering with the inactivation of this neurohumor by the enzyme cholinesterase.

General effects of drugs

It has been observed that all the central nervous system depressant drugs, such as barbiturates and opium derivatives, cause elevation of the total acetylcholine content of the brain. These drugs produce depression of the brain activity by interfering with the release of acetylcholine even on receipt of stimulation. On the other hand, in various excited conditions like tremors and convulsions there occurs a significant decrease in the brain acetylcholine. All cholinergic drugs such as pilocarpine increase the brain acetylcholine and the anticholinergic drugs such as atropine cause a reduction in the acetylcholine content of the brain. All the CNS stimulants such as nicotine decrease the acetylcholine content, whereas the cholinesterase inhibitors like eserine increase the acetylcholine content of the brain. The drugs which increase the acetylcholine content of the brain produce slow EEG waves, and those which decrease the acetylcholine content produce enhanced EEG waves.

Acetylcholine receptors

Pharmacologists have recognized two types of cholinergic receptors viz. nicotinic and muscarinic cholinergic receptors. The former may be stimulated by the direct application of acetylcholine or nicotine, and this activity is not blocked by atropine. Various viscera supplied by parasympathetic nerves possess muscarinic cholinergic receptors. They can be stimulated by acetylcholine or muscarine, but not by nicotine. This activity is antagonized by atropine which is a specific muscarinic blocker. The autonomic ganglia and cortical and subcortical regions of the brain contain mostly the muscarinic receptors. The acetylcholine binding properties of the receptor are similar to those of acetylcholinesterases.

In Myasthenia gravis, which is characterized by severe muscle weakness of the body, there occurs a low content of acetylcholine receptors in the affected muscles, which in due course would lead to low acetylcholine release at the nerve endings. This condition can be relieved by giving synthetic cholinergic preparations like prostigmine (Fig. 6). In all the stressful situations as will be discussed later, the liberation of

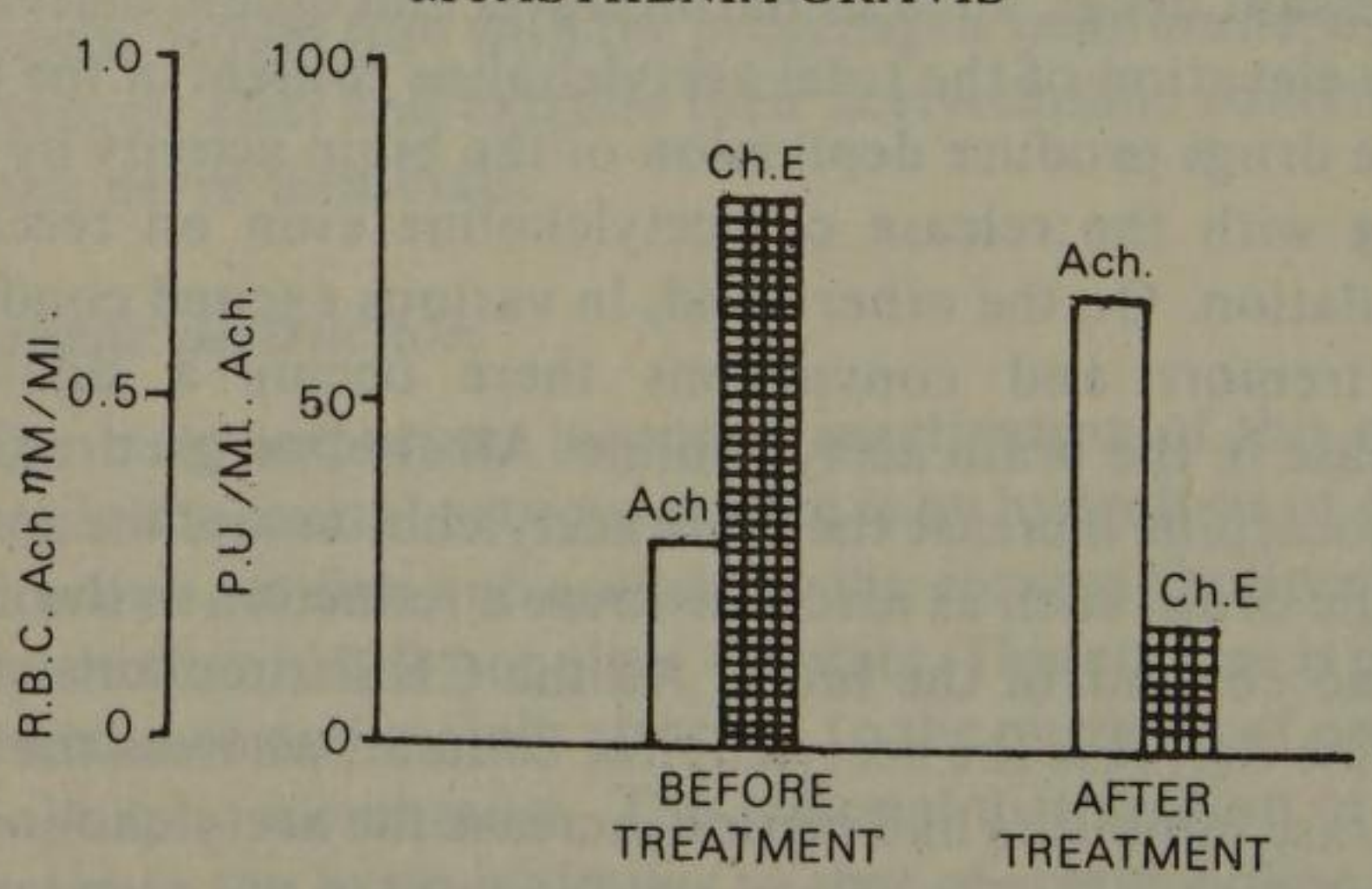


Fig. 6. Shows neurohumoral status in Myasthenia gravis before and after treatment with Prostigmine. Note that before treatment there was a marked deficiency in acetylcholine and a high content of cholinesterase in the blood. However, after the treatment with Prostigmine the acetylcholine content increases with a marked decrease in the cholinesterase.

acetylcholine is increased from the cerebral cortex which in turn circulates in the whole body to excite its metabolic activities. In that respect one can say that acetylcholine is the initiator of all the changes that take place in the stressful situations.

Catecholamines

During the last two decades a rapid increase in our understanding of catecholamines has taken place and it is difficult to touch upon all these aspects in this short review. Therefore, those who want to know more about these important biogenic amines, may refer to the original papers of Julius Axelrod, and Von Euler. There are three important catecholamines in our body and they are noradrenaline, adrenaline and dopamine. Noradrenaline is primarily localized in the sympathetic nerves of the peripheral organs and tissues and in some nerve tracts of the brain. These noradrenergic nerve tracts originate in the brain stem and branch off to the hypothalamus, hippocampus, cerebral cortex and cerebellum. The adrenaline is produced mainly in the adrenal medulla. It is from here that it is released through stimulation of the splanchic nerves. Recent work has, however, shown the presence of adrenergic tracts in the midbrain. From here the cell bodies send off their axons into parts of the hypothalamus.

Dopamine was once thought to be only the precursor of noradrenaline, but now it has been shown that it has its own function. It is localized mainly in the nerve tracts in the brain. Its cell bodies originate in the substantia nigra in the midbrain where it also contributes to the formation of melanin (black) pigment. Its axons course through the lateral hypothalamus and terminate in the caudate nucleus and putamen of the corpus striatum.

Recent studies with fluoroscent microscope have shown that the catecholamine secreting nerves consist of a cell body, a long axon, and highly branched nerve terminals. The catecholamines are stored in dense vesicles present in their nerve terminals. In the adrenal medulla the adrenaline is stored in the chromaffin granules.

DISPOSITION OF NORADRENALINE, (NA) RELEASED FROM SYMPATHETIC NERVE ENDING

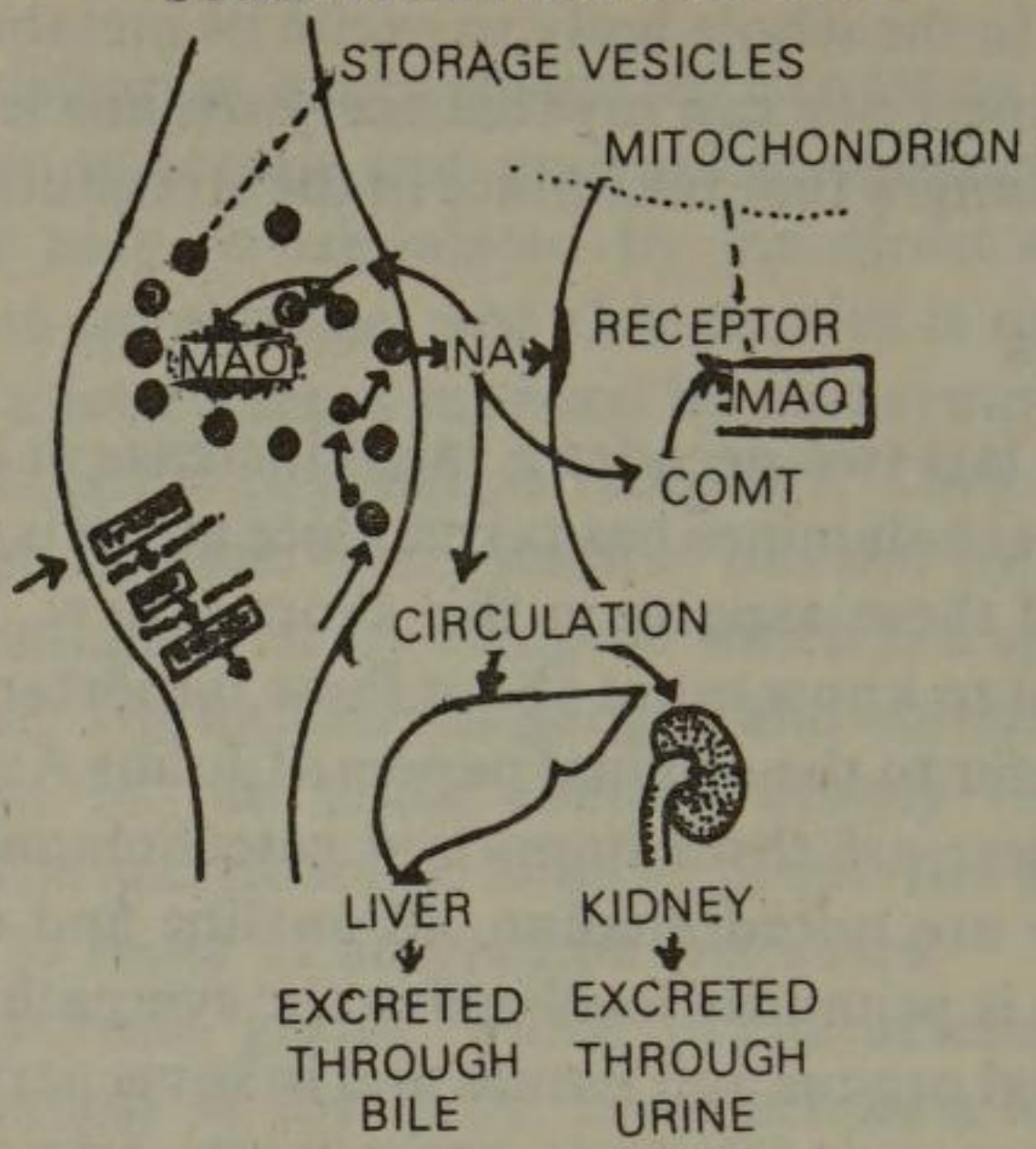


Fig. 7. Shows the mechanism of synthesis of noradrenaline in the sympathetic ganglia, its release and reuptake and also the method of degradation in the target cell. Such degraded products are ultimatly excreted through kidneys and liver.

Catecholamine synthetization consists of the following steps: The aminoacid tyrosine is converted into DOPA by the enzyme tyrosine hydroxylase. Dopa is changed into dopamine by the enzyme Dopa decarboxylase. Dopamine is converted into noradrenaline with the help of the enzyme dopamine-B-hydroxylase (DBH). The noradrenaline is changed into adrenaline in the adrenal medulla with the help of the enzyme, Phenylethanolamine-N-Methyl Transferase. All these enzymes are present in the sympathetic nerve terminals and also in the adrenal medulla. These catecholamines act as neuro-humors at the synaptic junctions and produce quick changes in the post-synaptic cells by acting through their receptors. Further, adrenaline and noradrenaline secreted by the adrenal medulla circulate in the blood and produce changes in the distant target organs in the same way.

The catecholamines are degraded by four mechanisms: (1) O-Methylation by catechol-O-Methyl Transferase, (2) Deamination by Monoamine oxidase, (3) Absorption into the blood

stream through capillaries leading to metabolic degradation in liver and kidneys, and (4) Re-uptake into the nerve terminals (Fig. 7).

The catecholamine levels in the blood are constantly changing as they are being continuously synthetized, released and metabolized in various organs and tissues. However, through various regulatory mechanisms they normally remain within permissible limits. One of the important regulatory systems is the rate limiting enzyme—Tyrosine Hydroxylase whose excess production is prevented by the presence of adequate amount of catecholamines. When the level of catecholamine falls the activity of the tyrosine hydroxylase increases. This leads to more production of Dopa, Dopamine and noradrenaline. In addition, a few other mechanisms which play a minor role in the regulation of catecholamines are: (1) Inhibitory role of adrenergic receptors located presynaptically and (2) Formation of Dopamine-B-Hydroxylase in the sympathetic nerves and adrenal gland.

In addition, the conversion of noradrenaline into adrenaline is closely controlled by the adrenocorticoids secreted by the adrenal cortex. These corticoids control the formation of adrenaline by regulating the formation of PNMT. If hypophysectomy is done, PNMT falls in the adrenal medulla and it can be restored to normal either by injecting ACTH or by giving Dexamethasone. All these findings indicate that conversion of noradrenaline into adrenaline is controlled by the glucocorticoids secretion from the adrenal cortex perfusing the adrenal medulla through the cortical blood vessels draining into the medullary ones. In addition, hypophysectomy also produces decrease in the tyrosine hydroxylase and also the enzyme DBH within 2 to 3 weeks which can be restored to normalcy by injecting ACTH.

CATECHOLAMINES IN HYPOTHALAMUS

It has been well established that catecholamine containing cell bodies and nerve terminals exist in various regions of anterior hypothalamus and median eminence. Here the maximum quantity of Dopaminergic and Noradrenergic fibres are

found in the neighbourhood of median eminence indicating that these amines play an important role in this part of the hypothalamus. The ventromedial aspect of the hypothalamus contains the least amount of noradrenergic fibres. In addition to the above, the pineal gland which secretes the hormone "Melatonin" is heavily innervated by noradrenergic nerve terminals whose cell bodies are located in the superior cervical ganglion. It is through these noradrenergic nerve fibres that the body tries to regulate the synthesis and release of Melatonin which in turn influences the reproductive cycle of the animals.

METHOD OF ESTIMATION

Bioassay procedure still remains one of the most sensitive methods for the estimation of adrenaline and noradrenaline in the tissue extracts and biological fluids. However, the main disadvantage of this method is the lack of specificity. Because of this, the method is gradually being replaced by the chemical ones.

The development of sensitive fluorometric techniques has been the major factor in the rapid advancement of knowledge in the field of catecholamines. There are at present two well established chemical procedures for the estimation of catecholamines after their conversion into fluorescent derivatives, the ethylene diamine condensation method and trihydroxyindole method. For further details readers are requested to refer to original papers of the authors. Suffice it to say here that these techniques have greatly facilitated the studies of catecholamines in the body tissues and fluids. In addition, recently few methods have also been described in which Gas Chromatographic techniques and Radio-Isotopic methods have been used.

In recent years, Hillarp and Falck have developed a histochemical fluorescent technique to demonstrate the presence of catecholamines in adrenergic nerve endings and other tissues. This method is essentially based on conversion of catecholamines and their respective aminoacids to highly fluorescent derivatives in the presence of relatively dry formaldehyde vapor at 66 to 80°C. By this procedure it is now possible to localize catecholamines and their precursors within the histo-

logically recognizable microscopic structure when examined under the fluorescent microscope. The use of this fluorescent histo-chemical technique in the study of central nervous system has revealed the entire catecholaminergic neural pathway and its cell bodies and also has enabled us to map out the extensive monoaminergic pathways in the brain. Further, by using various monoamine inhibitors we can also assess the action of these drugs on different parts of the brain. It seems that the entire catecholamines in the brain are contained within the enlargement of nerve terminals instead of cell bodies or their axons. Therefore, it seems that these amines which are present in the presynaptic nerve terminals are mainly involved in the storage, release, reuptake and sythesis. The quantitative distribution of catecholamine in various parts of the body depends upon the amount of sympathetic nerve terminals present in each organ. They are present in larger quantity in the cardiovascular system, spleen and vas deferens. In the brain noradrenaline is present in a large quantity in the hypothalamic region while dopamine is present in a large quantity in the substantia nigra and caudate nucleus.

EFFECT OF DRUGS

It was at first observed that reserpine which is a potent hypotensive and tranquillizing agent caused a depletion of brain catecholamine. On the other hand, the use of various monoamine oxidase inhibitors, which increase the catecholamine content of the brain, stimulated the depressed brains. Thus, all the tranquillizers such as diazepam and its derivatives reduced the catecholamines of the brain especially of the hypothalamic region. On the other hand, various psychomotor stimulants such as amphetamine, and other similar drugs increase the catecholamine content of the brain. From these findings of drug actions one can also deduce that just as catecholamines act on the peripheral organs during stress and strain, they may also play significant role in the stressful situation of the central nervous system. Thus, now it is being established that behavioural depression is associated with defi-

ciency of catecholamines (usually noradrenaline) at various functionally important nerve centres. On the other hand, it is markedly increased in stressful and psychically excited situations. It has also been ascertained that by the use of drugs mentioned earlier these abnormal situations can be reversed towards normalcy. However, there is a great scope for further elaboration of all these actions of catecholamines in the brain.

CATECHOLAMINE RECEPTORS

There are two types of receptors for catecholamines in the peripheral system—alpha receptors and beta receptors. These receptors are pharmacologically defined by their ability to block these receptors by two classes of drugs. The most commonly used alpha blockers are phenoxybenzamine, the ergot alkaloids and phentolamine. The most widely used beta blocker is propranalol. Both types of receptors are stimulated by the catecholamines themselves and by the sympathomimetic drugs to different extent, whereas the blocking agents generally affect one type of receptor exclusively. These receptors can be recognized by the pharmacological means only and their biochemical characteristics are not yet clear. Further, it is also now realized that the brain catecholamines do not exactly follow the receptor mechanisms found in the peripheral organs.

In addition to these blocking agents, one should also know two important drugs which modulate catecholamines in the body viz. L-dopa and 6-Hydroxy dopamine. L-dopa is particularly effective in alleviating the symptoms of Parkinson's disease. In this disease there is loss of catecholaminergic neurons which originate in the substantia nigra in the midbrain. These neurons use dopamine as their neurohumors. In such cases with deficienty of dopamine the drug L-dopa increases the activity of these neurons in the substantia nigra and alleviates many of the symptoms of Parkinsonism.

The injection of 6-Hydroxy dopamine into the body causes selective destruction of catecholamine containing neurons, thus, causing chemical sympathectomy. This drug does not

cross the blood brain barrier and hence it is injected locally into the brain to destroy selectively the catecholamine producing neurons. These are some of the properties of catecholamines, a detailed knowledge of which is essential to the study of stress disorders.

QUANTITATION OF STRESS BY CATECHOLAMINE ANALYSIS

It is now well established that there exists a good correlation between various kinds of physical and mental stresses and the activity of the sympatho-adrenal system. In general, it may be stated that release of adrenaline from the adrenal medulla is the most common response to various stressful situations which involves certain degree of emotional disturbance. The activation of noradrenergic system in the sympathetic nerve endings usually occurs mostly after physical stimuli causing increased blood pressure. This can be measured by estimating these catecholamines in blood or urine. However, it has been observed by many that the determination of plasma catecholamine may not be the sole representative of the sympatho-adrenal system of the body since it may alter even on slight physical or mental disturbance. Hence, estimation of urinary excretion of adrenaline and noradrenaline has been found to be a more reliable indication of the status of sympatho-adrenal system. Even urinary excretion of VMA, a metabolite of catecholamine may not be the real indication of stress, since it does not differentiate adrenaline or noradrenaline in the urine.

As already stated, noradrenaline release is less affected by emotional stimuli than adrenaline. However, marked increase of noradrenaline occurs when stress is given to the animal in the form of excessive cooling or heating. Normally, adrenaline excretion in the urine comes to about 2 to 3 nanogram per minute and that of noradrenaline 6 to 10 nanograms. It is also known that various conditions of mental stress are accompanied by markedly increased excretion of adrenaline with relatively moderate increase of noradrenaline. Such an investigation can enable us to assess quantitatively the degree of stress by knowing the amount of adrenaline excretion in the

urine. In all cases of physical stress involving bodily discomforts, such as exposure to heat, cold, pain and bodily distress, it is the noradrenaline that is increased in the urine and its severity can also be quantitatively assessed by the degree of incease in the noradrenaline excretion. All these problems will be discussed again along with the problems of different types of stressful situations.

Histamine

There was some doubt whether histamine could be called neurohumor, though it is found in significant concentraton in the brain and in other nerve tracts. It is produced from histidine by a specific enzyme histidine decarboxylase which is pesent in the brain in abundance and is metabolized into imidazoleacetaldehyde by the enzyme histaminase. However, the doubt has now been dispelled as a result of extensive work of several workers in the field. It is found in abundance in the hypothalamus-hypophyseal region and in moderate quantity in midbrain and least in the cerebral cortex. It is suggested that apart from its own action it also potentiates the action of acetylcholine and in higher quantity it may inhibit the synaptic transmission of acetylcholine. In all other parts of the body the main source of histamine is the granules present in mast cells. However, such mast cells are absent in the central nervous system and hence the source of CNS histamine must be some other cellular component. Such subcellular distribution of brain histamines is consistent with the hypothesis that it is contained in the nerve endings. It is also interesting to note that the general distribution of histamine in the brain is quite like that of other biogenic amines such as noradrenaline and 5-Hydroxy-tryptamine.

Histamine is formed from histidine with the help of histidine dicarboxylase and then it can be converted into methyl histamine and methylimidazole acetic acid. The methylating enzyme required for this purpose is the imidazole-N-methyl transferase, an enzyme which can be isolated from the brain. Histamine metabolism can be influenced by various drugs. For example, reserpine reduces the concentration of histamine in

HISTAMINASE AND HISMAMINE IN DIFFERENT AGE GROUPS IN MALE

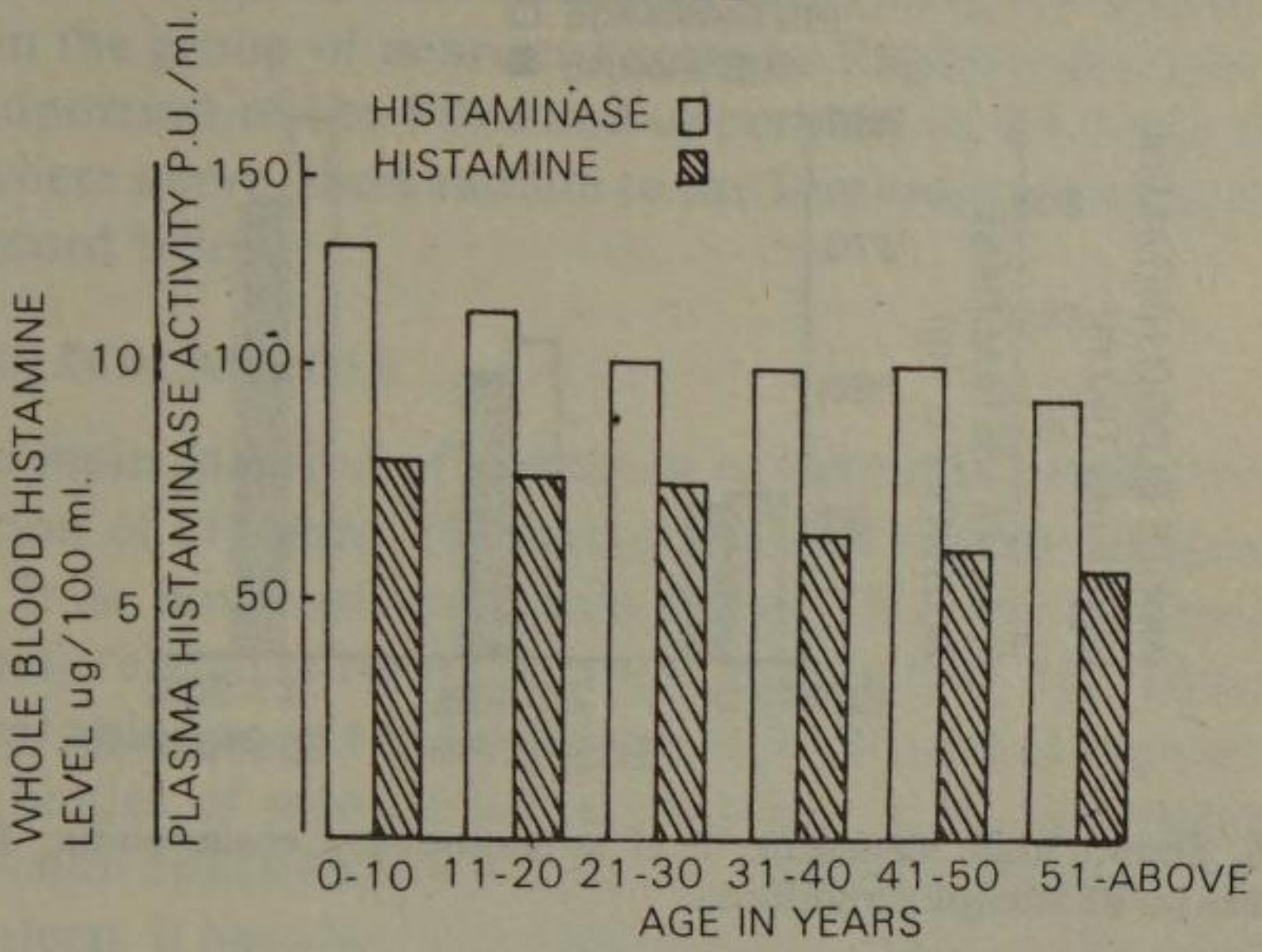


Fig. 8. Shows the blood histamine and histaminase levels in different ages. It should be noted that as age advances histamine and histaminase become less and less.

the hypothalamus and thalamus just as it reduces the concentration of other amines. Tremorine also decreases brain histamine. Chloropromazine which inhibits N-menthyl transferase increases the histamine concentration. But, all these findings do not exactly explain the function of histamine in the central nervous system. However, from their close association with the catecholamines, one can say that histamine by its vasodilating effect may be modulating the action of catecholamines. Thus, histamine may be functioning as a safety measure, which would prevent the excessive or prolonged vasoconstrictive action of catechlamines especially of noradrenaline in the brain. In this way, it may be said that histamine takes an active part in maintaining an efficient microcirculation in the brain as it does in other parts of the body. Normally it takes active part in growth and regeneration (Fig. 8). Pathologically it is increased in all allergic conditions (Fig. 9).

HISTAMINASE AND HISTAMINE IN PATIENTS OF TROPICAL PULMONARY EOSINOPHILIA

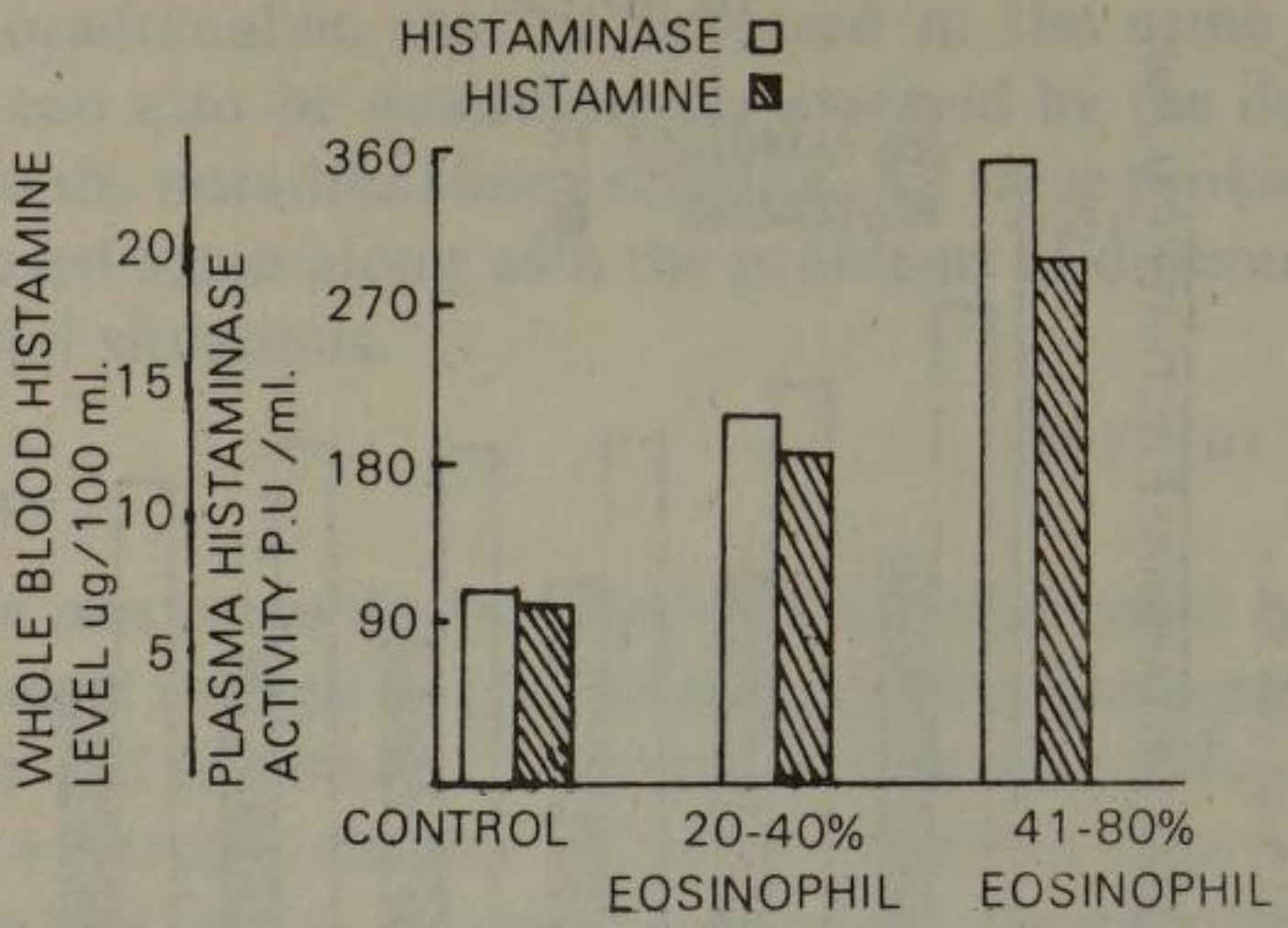


Fig. 9. Shows high histamine level in pulmonary eosinophilia. It also increases in all allergic conditions.

Serotonin (5-Hydroxytryptamine):

Serotonin occurs widely in nature. It is found in many types of fruits such as bananas and pineapples in large quantity. In mammals, the highest concentration of this material occurs in the pineal gland and in the enterochromaffin cells of the intestinal tract. In human beings, it is estimated that about 90% of Serotonin occurs in gastrointestinal tract; about 8 per cent in platelets and only 2% within the central nervous system. Its synthesis occurs in various parts of the body by absorption of dietary tryptophan from plasma. Thereafter, in the presence of tryptophan hydroxylase this aminoacid is converted into 5-Hydroxytryptophan (5-HTP). This reaction can be blocked by p-chlorophenylalanine. After the synthesis of 5-HTP it is immediately decarboxylated to serotonin by the enzyme decarboxylases. Once serotonin is formed it may remain deposited at the place of synthesis or it may be catabolized by its deamination by the enzyme monoamine oxidase to ultimately form 5-Hydroxyindoleacetic acid (5-HIAA). In general, the rate of formation of serotonin is controlled by its rate limiting enzyme tryptophan hydroxylase.

In the brain, the histochemical and fluorescent microscopy showed that almost all the serotonin containing cell bodies are found in the group of neurons known as Raphe nuclei lying in the midportion of the Pons and upper part of the brain stem from where nerve fibres radiate to the forebrain above and the spinal cord below.

PHYSIOLOGICAL ROLE

The main function of serotonin in the brain consist in the regulation of (1) sleep, (2) perception and (3) temperature.

(1) It is now well established that 5HT in the brain is intimately related to the mechanism of sleep (Fig. 10). Thus, by electrical ablation of the Raphe nuclei which act as depository of cell bodies of serotoninergic neurons, or by pretreatment with p-chlorophenylalanine one can induce a marked reduction in sleep. It has also been observed that relative loss of sleep time appears proportional to the extent of serotonin loss. On the other hand, an intraventricular injection of serotonin or parenteral administration of 5-HT causes increase in sleeping time. However, acetylcholine and catecholamines may also play some role in modulating the sleep mechanism through Raphe nuclei.

DIURNAL VARIATION OF PLASMA AND BRAIN 5-HT IN RATS

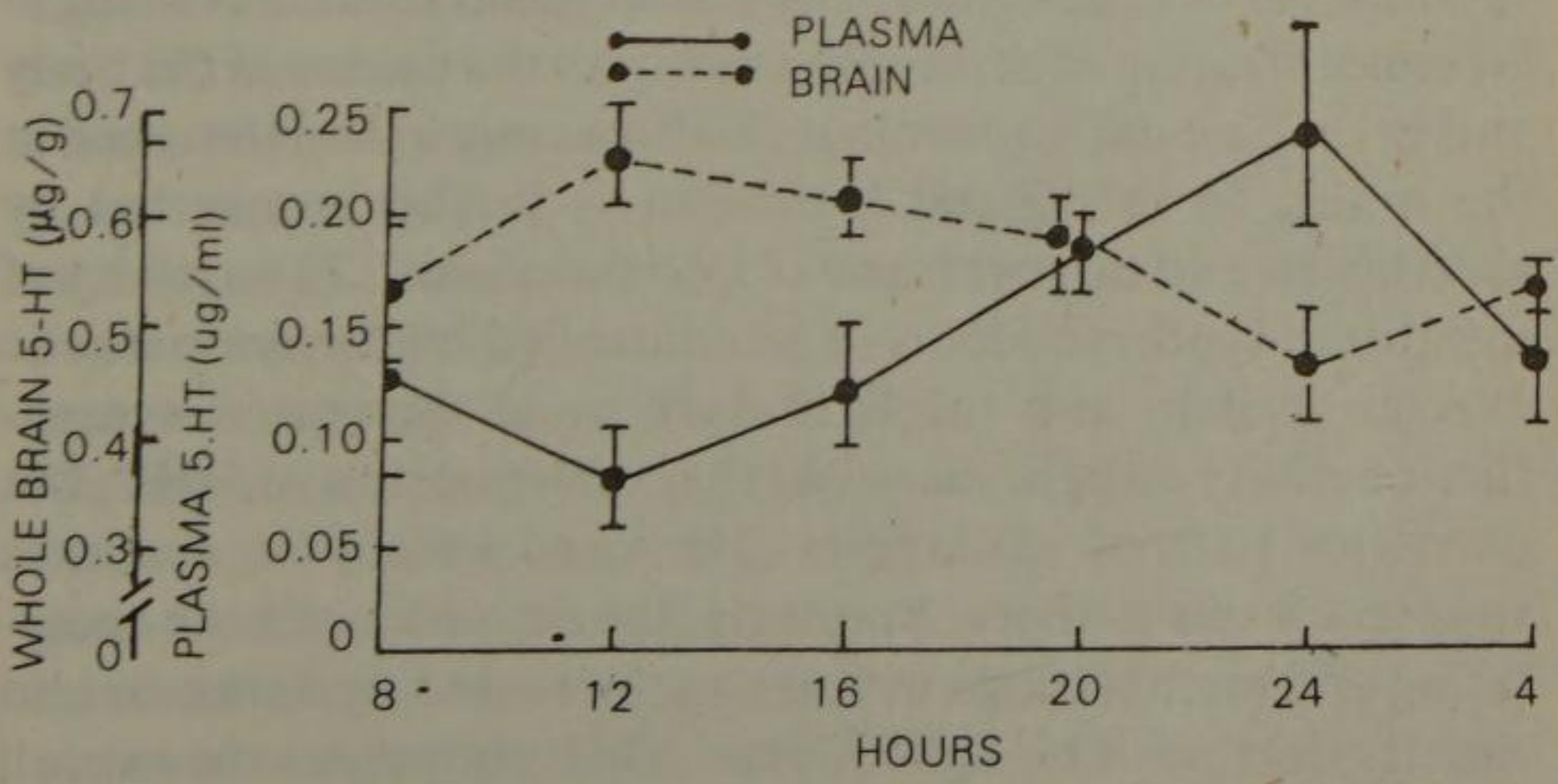


Fig. 10. Shows the diurnal variation of plasma and brain 5-HT in rats. Note that at the time of sleep the brain 5-HT remains lowest while the Plasma 5-HT remains at the highest level.

In addition, serotonin injection into the ventricles causes profound rise of body temperature. However, if the serotonin content of brain is depleted, this elevation of body temperature does not take place. It does not automatically cause hypothermia.

The sensory perception mechanism is also disturbed if the serotonin content of brain is reduced by drugs. Thus, following the reduction of serotonin content of Raphe nuclei, animals exhibit decreased motor activity, decreased emotional reactivity and increased sensitivity to painful stimuli.

Method of Assay

Serotonin in the tissue extracts and biological fluids including plasma is best estimated by spectrophotofluorometry. This is a very sensitive technique. Fluorescence microscopy can also be adopted to detect 5-HT in histological preparations. By this one can visualize serotonin containing neurons in the Raphe nuclei present in the pons and brain stem.

PINEAL GLAND

Pineal is a very small gland in the brain, dorsal to the thalamus. It is innervated only by sympathetic nerves from superior cervical ganglion. The Pineal gland contains the highest concentration of serotonin among all the tissues of the body and in rats, pineal serotonin is 200 times more than that seen in the brain. In this gland serotonin is further converted by acetylation and methyl transfer into melatonin. The activity of melatonin synthesis seems to be controlled by the sympathetic nervous system and the light-dark cycle. Increased sympathetic activity or light increases the concentration of 5-HT, but decreases that of melatonin. The denervation or darkness suppresses this activity. Similarly, the activities of both acetylating and methylating enzymes are increased by darkness and rapidly decreased by light. Cyclic AMP stimulates the overall rate of 5-HT and melatonin synthesis. Sympathetic stimulation produces a similar reaction possibly mediated through

adenyl cyclase of adrenal gland. Skin colour is controlled by the pituitary melanocyte stimulating hormone (MSH) and melatonin. In many other species, it is also important in sexual development as it suppresses the formation of female gonads and the size of seminal vesicles. It is related to the development of oestrus cycle in animals. However, its definite role in the reproductive physiology needs further study.

Gamma-aminobutyric Acid (GABA)

The first report about the presence of GABA in the central nervous system was made in 1950. A number of investigations have now established that it is an inhibitory transmitter in the vertebrate central nervous system (CNS). It is formed to a large extent, if not entirely, from L-Glutamic acid. Its conversion into GABA is catalyzed by L-glutamic acid decarboxylase (GAD), an enzyme present only in mammalian CNS. It is degraded by the enzyme GABA transaminase present in those areas of the CNS where the concentration of GABA is also found in excess. GABA is intimately related to the oxidative metabolism of the carbohydrates in the central nervous system.

The neurotransmitting action of GABA has been studied extensively. At present, there is sufficient evidence regarding the production, storage and pharmacological activity of GABA which demonstrates its role as an inhibitory transmitter. However, inhibitory pathway of GABA in the cerebral cortex has not yet been clearly demonstrated. It is well established that there is a spontaneous release of GABA from the surface of the brain and also from the deeply seated nuclei of the brain such as amygdala, caudate nucleus etc. GABA is also known to be concentrated in the Purkinje cells in the cerebellum which have inhibitory effects on various subcortical nuclei of the cerebellum adjacent to fourth ventricle. Various investigations, appear to support the hypothesis that GABA is an inhibitory transmitter (Fig. 11). Further, there seems to be no pharmacologically sensitive mechanism for the rapid destruction of GABA similar to cholinesterase mechanism for the destruction of acetylcholine. Similarly, there is no definite

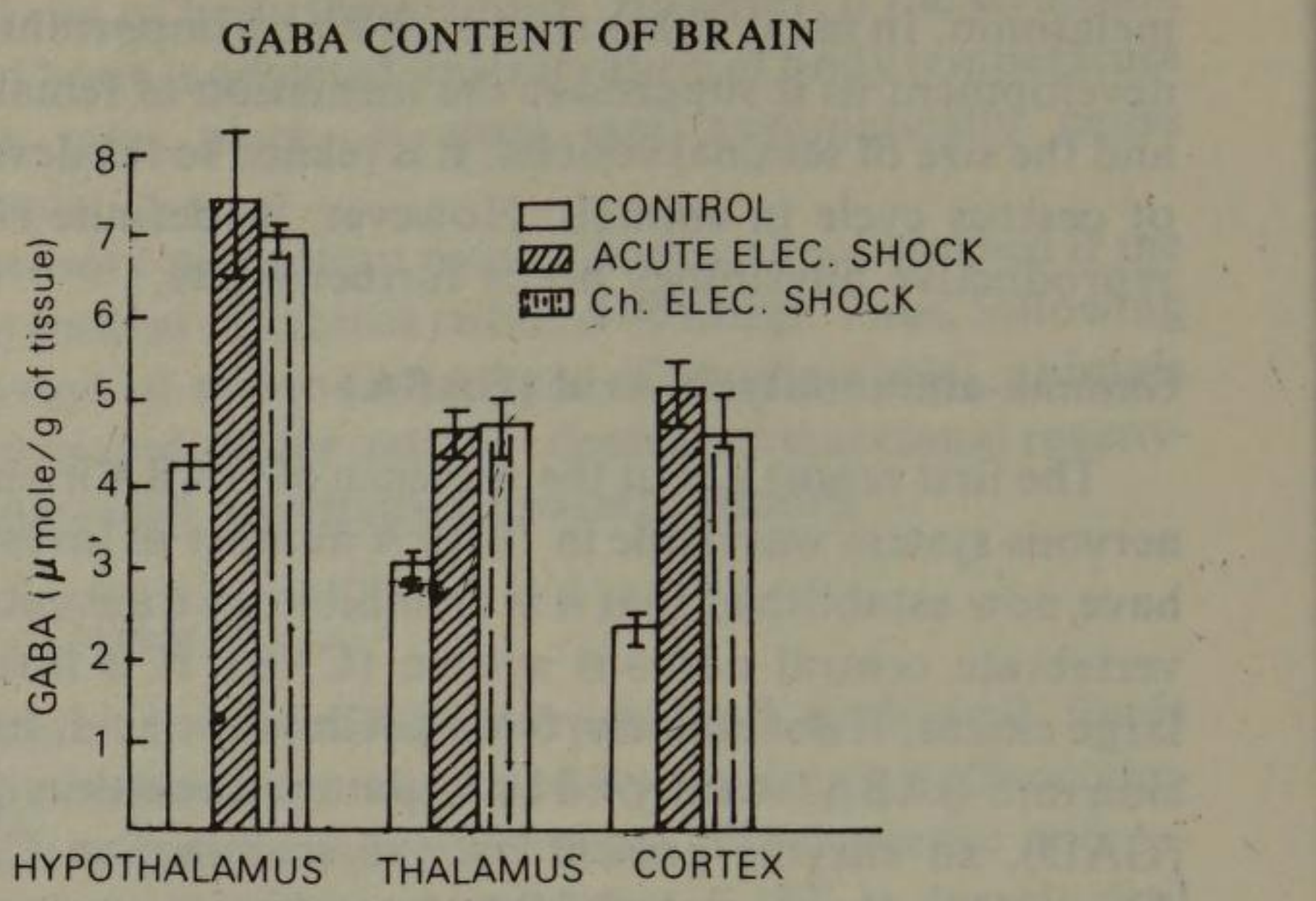


Fig. 11. Shows the Gamma-aminobutyric acid (GABA) content of rat brain. Here one can see that after the acute and chronic electric shock there was a marked rise of GABA in the rat brain which is just opposite to the action of brain acetylcholine.

evidence to indicate how the action of GABA is terminated. However, it seems that some uptake mechanism works in the brain for recycling GABA and terminating its action. Thus, the development of any new technique which could help in assessing the turnover of GABA *in vivo* would greatly add to a better understanding of the functional importance of GABA in the central nervous system.

In Huntington's Chorea there occurs continuous extensive involuntary movement along with low concentration of GABA in the substantia nigra, putamen, globus pallidus and caudate nucleus. This is associated with the deficiency of the enzyme GAD and may indicate degeneration of the GABA containing cells in these tracts. This also suggests that in all the diseases with involuntary movements or convulsions GABA might be playing some important role. However, this needs further investigation.

GLYCINE

Quite a number of observations tend to suggest that the amino-acid glycine may play the role of inhibitory transmitter in the mammalian spinal cord. These indications are based on the fact that this amino-acid is found in relatively high concentration in the spinal cord as compared to other amino-acids. Further, glycine is found concentrated more in the spinal grey matter, especially in the ventral horn, than in the white matter suggesting that it may be associated with inhibitory interneurons. However, glycine is quite ineffective as an inhibitor of cerebral cortex, unlike GABA which acts as an inhibitory agent both for cortex and spinal cord. The uptake of glycine may be related to sodium, through which its action is possibly terminated. However, the mechanism of its release and its pathway is still not very clearly known. Strychnine is known to block the action of glycine. Thus, strychnine acts as a convulsant by blocking the post-synaptic membrane of the inhibitory neurons leading to incoordination of motor activity.

GLUTAMIC ACID AND ASPARTIC ACID

Glutamic acid and aspartic acid stimulate the central nervous system and are found in abundance in these regions. It is difficult to say at present whether or not they act as transmitters in the central nervous system. However, when the CNS is stimulated there occurs an excess outpouring of these amino-acids. Whether they come from blood or they are put out by the neurons of the cerebral cortex, it is difficult to ascertain. In the spinal cord, these act as excitants of the interneurons, motor neurons and also of the sensory nerve endings at the dorsal region of the spinal cord. Both glutamate and aspartate are common intermediary metabolites of neural tissue and hence, they can become available in all parts of the CNS. These findings tend to suggest that the response to these amino-acids represents a nonspecific activity of the neurons to these agents and is not indicative of any transmitter function. However, they may serve as final excitory agents in the synaptic transmission. The studies so far conducted indicate that glutamic

and aspartic acids function as excitory agents and GABA and glycine act as inhibitory agents.

PROSTAGLANDINS

Prostaglandin is an active acidic lipid with a specific property of stimulating or depressing the smooth muscles. There are a number of naturally occurring prostaglandins, but two of them viz. prostaglandin E and prostaglandin F are important. Although, it is known that they have many roles to play in the body, here we will discuss only the neurohumoral role of prostaglandins. The stimulation of the splanchnic nerve in dogs and cats causes an output of large amount of prostaglandin E^2. However, if the organism is pretreated with alpha adrenergic agents such responses are abolished. This indicates that PGE might be having a modulatory antagonistic action

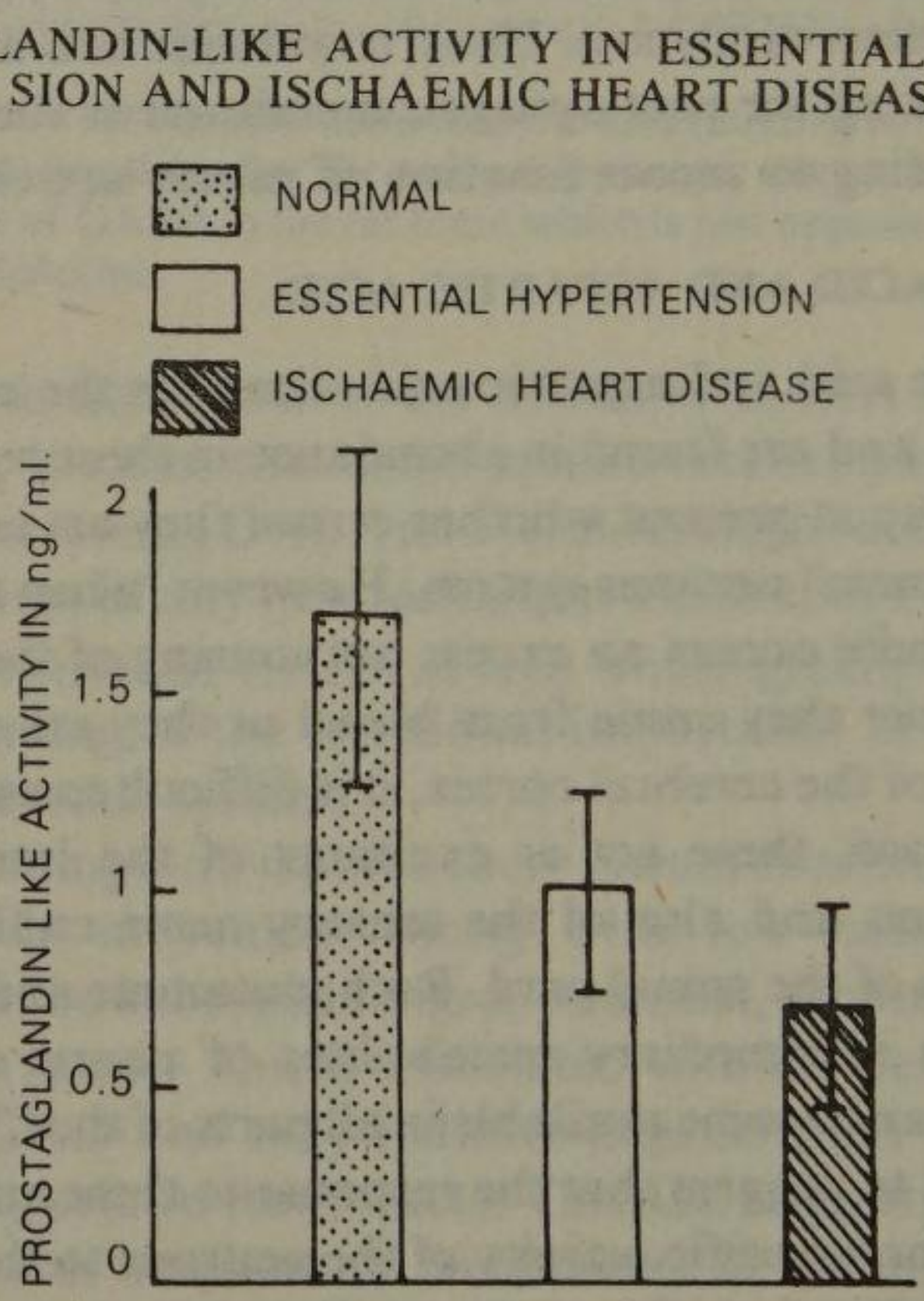


Fig. 12. Shows the prostaglandin-like activity in certain cardiovascular diseases. In hypertension it is reduced by about 40%, whereas in Ischaemic Heart disease it is about 60% less than the normal.

on the catecholamines (Fig. 12). In addition, it was found that both PGE and PGF series of prostaglandins are found in the central nervous system and exhibit a series of actions. However, there is not enough evidence to indicate definitely that they act as neurohumors of the central nervous system. There is some indirect evidence to support the view that prostaglandins may be playing a role in the transmission process in the CNS.

(a) PGE appears to be concentrated in sufficient quantity in the synaptosome fractions of the brain.
(b) They are the natural constituents and are synthetized and released on direct or indirect stimulation of the brain.
(c) When administered intraventricularly they produce gross physiological changes.

A number of pharmacological stimulants can induce release of prostaglandins from CNS. Amongst them Picrotoxin and strychnine are important ones. They are released from the surface of the sensory cortex and the release can be increased by direct or indirect stimulation of the cortex. Such a release from the cortex can also be increased if different nerves are stimulated. Thus, there is a considerable amount of evidence to indicate the role of prostaglandin in the central nervous system. However, their exact role in different areas of the brain needs further study.

ADENOSINE 3′-5′-MONOPHOSPHATE (CYCLIC AMP)

It is now well established after the work of Sutherland, that actions of many of the hormones are mediated through cyclic AMP present in the cells. Thus, adrenaline stimulates glycogenolysis in the muscles, lipolysis in fat cells and release of many of the hormones from endocrine glands. All this appears to be under the control of the cyclic AMP (Fig. 13). It is possible that hormones and neurohumors might also be acting on the brain through the cyclic AMP which is present in abundance in the brain. In fact, of all the mammalian tissues, the brain has the

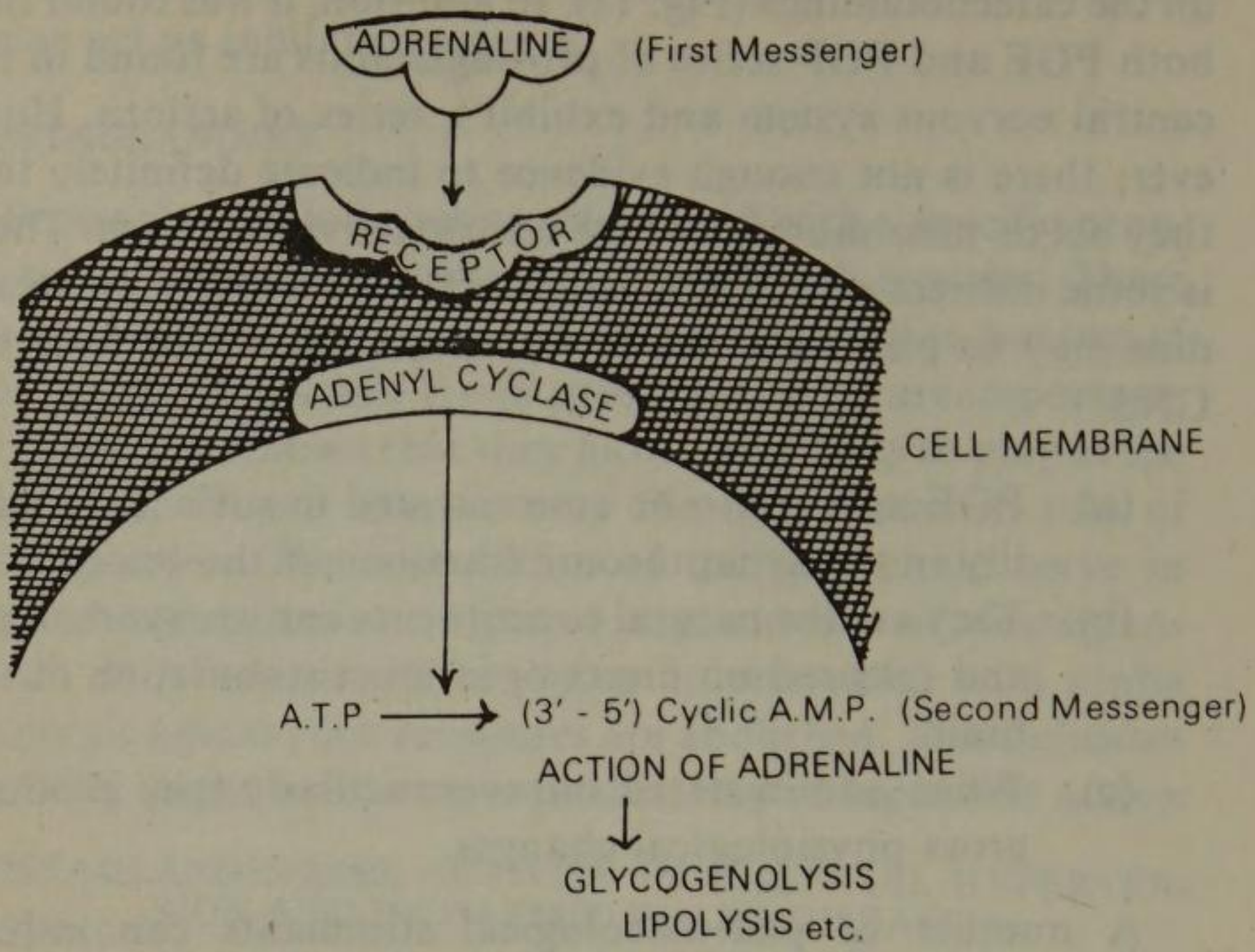


Fig. 13. Mechanism of action of cyclic AMP on the cell membrane. The hormone at first acts on the receptor which stimulates adynylcyclase enzyme present in the cell membrane to reduce ATP into 3' -5' cyclic AMP and liberate energy for hormonal action like lipolysis etc.

URINARY CYCLIC-AMP LEVELS IN CASES OF BRONCHIAL ASTHMA AND THYROTOXICOSIS

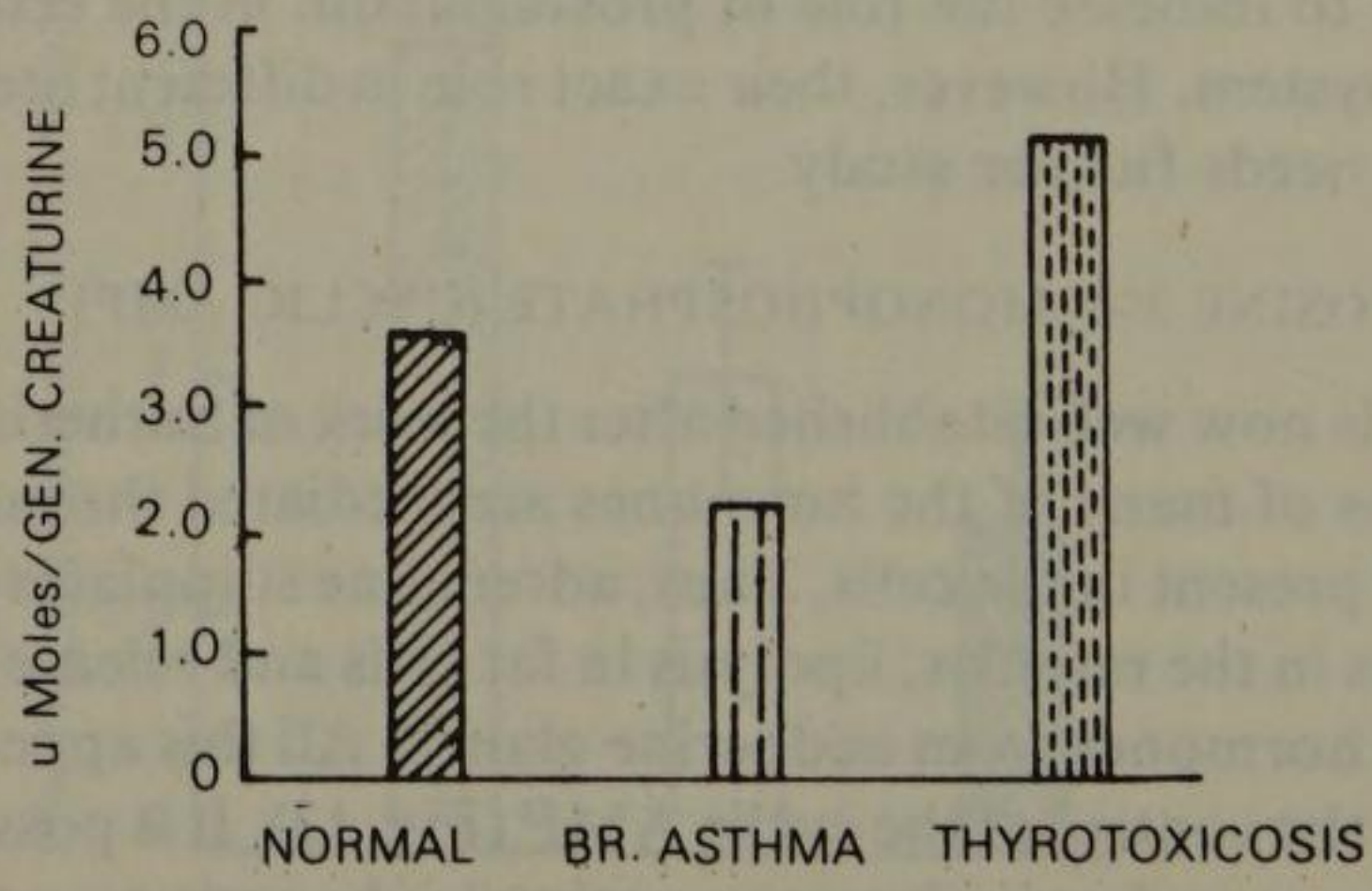


Fig. 14. Shows that in some stress disorders such as thyrotoxicosis, the urinary excretion of the cyclic AMP is increased whereas in bronchial asthma the cyclic AMP excretion is reduced.

highest concentration of the enzyme adenyl cyclase which catalyzes the synthesis of cyclic AMP and the phosphodiesterase which hydrolyzes the cyclic AMP. Caffine and Theophylline stimulate central nervous system inhibiting phosphodiesterase which leads to increase in the concentration of cyclic AMP. From all these evidences one can say that cyclic AMP plays an important role in modulating the action of different neurohumors at the cellular and molecular level and hence one should know the details of its action in relation to different neurohumors already described. Recently, in certain clinical conditions, such as in bronchial asthma, it was found much decreased whereas in other conditions, such as thyrotoxicosis, it was found much increased (Fig. 14). From these observtions one can say that cyclic AMP also plays an important role in mediating the activities of all the neurohumors in health as well as disease.

CHAPTER 4

Neurohumoral Response to Stress

Visceral Sensation

Broadly there are five types of sense qualities in the external environment which are perceived by the five sense-organs located in the body. The sensory receptors involved therein are called exteroceptors. Some receptors are imbedded in the internal organs, such as all the viscera, endocrine glands and blood vessels. These are called interoceptors which have three parts viz. (a) peripheral division containing sensitive nerve endings, (b) intermediate division or conducting pathways upto subcortical level, and (c) central division consisting of nuclei in the cerebral cortex. The interoceptors are either capsulated or uncapsulated. They are highly specialized and are capable of reacting to specific mechanical, thermal, osmotic and other stumuli promptly. Chemo-receptors readily respond to internal chemical changes. In the process of transformation of chemical stimulation into nerve impulse, acetylcholine released from nerve endings plays an important role. The presence of interoceptors in the blood vessels enables the cerebral cortex to regulate and maintain adequate blood supply to each organ. Thus, the main function of interoceptors is to keep the cerebral cortex informed about the activities of the organs supplied by it. Although, these receptors are present throughout the system, they are located in large numbers in certain areas like G.I. tract, Pyloric antrum, Ibocarcal region and rectum. In the cardiovascular system such a function is performed by carotid sinus and aortic arch. The main function of interoceptors is to regulate digestion, circulation, respiration, urine formation and all other autonomic processes. The func-

tions of these interoceptors can be modified either by the various stimulating agents at the visceral level or by the excitation or inhibition of the cerebral cortical centres. As already stated, in the intermediate division of the visceral sensory apparatus, afferent impulses travel along autonomic nerves, especially sympathetic nerves, as well as spinal nerves. In this way, the pathways from the receptors in the heart, lungs, stomach, iliocarcal region, rectum and bladder have been fairly well established through various segments of spinal cord. These pathways further pass through the spinal cord, medulla oblongata, subcortical regions, especially the reticular formation, hypothalamus and thalamus till they reach the cerebral cortex. In the cerebral cortex the messages are received especially by the limbic, premotor, orbital and other adjacent areas. In this way, the centres especially responsible for receiving visceral sensations are scattered all over cerebral cortex, especially in the anterior part. The final and accurate analysis of stimuli is done in association with other cortical centres (Fig. 15). In case of any pathological changes in the viscera messages from interoceptive apparatus reach the cerebral cortex from where the efferent impulses pass through hypothalamus and limbic system and produce various changes in the functioning of these organs through autonomic nervous system. In this connection Kurtsin states: "It was quite evident that the cerebral cortex is also greatly influenced by the nervous impulses arising in the receptors of the viscera, vessels and endocrine glands. These impulses reach the cerebral cortex via the nerves and provide nerve centres governing autonomic activity with information regarding state and performance of the internal structures. The information is then compared with the one which the cerebral centres received from the external environment. Only after a most complicated and detailed analysis of both these sources of information the cortical response is produced which determines not only the subsequent performance of the internal organ from which information was received but also the general behaviour of the body as a whole".

From this it is clear that there is a need for complete reappraisal of the relationship of the cerebral cortex and inter-

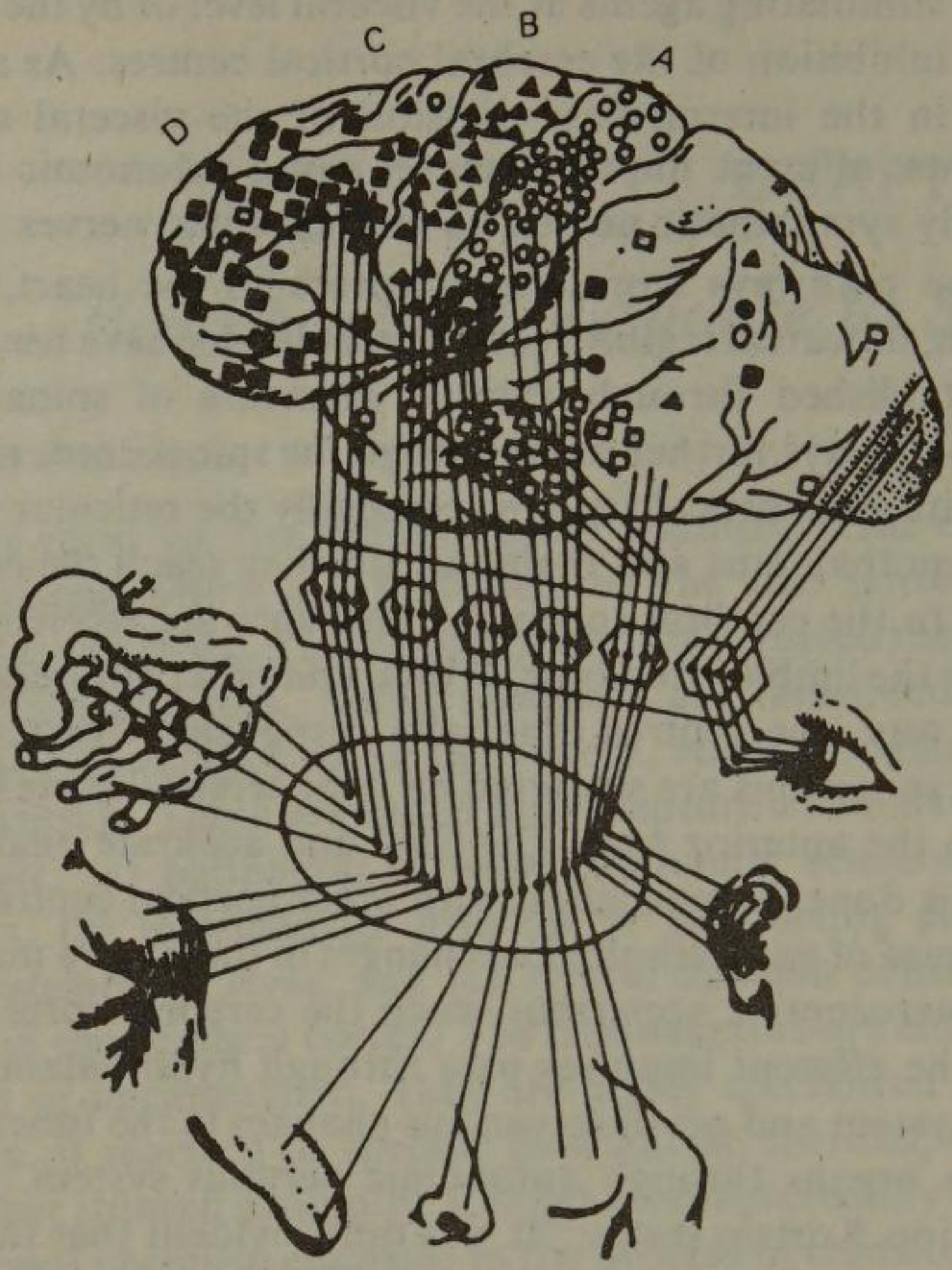


Fig. 15. Shows how different sensations from the sense-organs, viscera and muscles reach the respective areas of the cerebral cortex which ultimately integrates all of them at the Psychic centre to produce the appropriate response.

nal organs, which greatly influences the functioning not only of the autonomic nervous system but also of the emotions and behaviour of a person as a whole.

CLINICAL CONSIDERATIONS

It is now well established that many Psychosomatic stress disorders are caused by repeated and chronic exteroceptive stimuli especially through the auditory and visual organs

which ultimately stimulate the cerebral cortex to produce the necessary changes in the internal organs. However, it is not always realized by the clinician that any changes in the internal organs such as gastritis transmitted through interoceptors will also lead to disturbance in the higher nervous activity. Thus, it has been realized recently, that neurosis or psychosis can be caused by the presence of such disturbance in any one of the affected viscera. Further, occurrence of neurosis as a result of some disturbance in the cerebral cortex can also cause secondary visceral changes leading to a vicious circle. This has been confirmed by the experimental studies, whereby pathological changes in the internal organs were found to be accompanied by neurotic changes in higher nervous activity. The mechanism by which such a change happens was not known till intensive studies of interoceptive factors were carried out. Thus, the disturbance of higher nervous activity occurring in the presence of some pathological changes in the internal organs may be due to the shifting of interoceptive stimuli from the organ to the cerebral cortex. The resultant disturbances of higher nervous activity followed by disturbances of autonomic activity differed very little from the disorders caused by external enviornmental stress. In both cases, features depend upon the amount and degree of involvement of cortical and subcortical structures rather than the type of stimuli. Prolonged disturbances in an organ such as stomach, leading to gastritis or gastric ulcer induce functional or bio-electrical changes in the hypothalamus, reticular formation or limbic areas which may produce changes not only in the same organs, but also the other neighbouring organs, such as chronic hepatitis which can be associated with gastric ulcer. Thus, one can fully realize that for the development of psychosomatic stress disorders not only the external enviornmental stress factors operate on these patients, but sometimes the internal enviormental changes in any organ can also initiate changes in the cerebral cortex which may in turn produce distrubances in that and other neighbouring organs by developing functional changes in both these Viscero-Cortical centres. On the basis of experimental studies of Kurtsin one can say that when these disturbances ultimately

settle down in an organ, one can hardly find out any change in the manifestation of these disorders. Hence, while considering the pathogenesis and pathology of stress disorder one should take into account all these factors before finalizing the management of these disordes.

DEVELOPMENT OF PSYCHOGENIC STRESS

Now, one would like to question as to how an extremely powerful stimulus either auditory or visual can produce pathological reaction and what the initial features of the same are. Why the same type of stress produces different diseases in different people and why it manifests quickly in some after stress, whereas in others there is a long latent period before the disease manifests itself? In man, psychic trauma caused by emotional disturbances resulting from spoken or written word is the most common stressful situation. The effect of such psychic trauma can be greater than that of any type of physical trauma. Thus, a common stress disease like hypertension can be caused as a result of repeated minor mental trauma occurring in everyday life. Although, we now know that such diseases are caused by mental stress, we do not know exactly how the disease actually develops and what are the changes that occur in the body before the features of a particular disease make their appearance. It is now known, that, most of the stress diseases such as peptic ulcer, hypertension, thyrotoxicosis etc. are all preceded by some type of mental trauma and nervous strain induced by emotional disturbances. In some, the history of such psychic trauma is easy to trace, whereas in others it may be difficult since many a time the patients do not attach much importance to the mental strain as a causative factor for the subsequent development of the disease. It is a well known fact that during and immediately after the World War II the incidence of peptic ulcer and hypertension increased enormously in people living in war affected areas. Same is the case in areas effected by floods and earthquakes. However, all the people living in such areas did not develop stress disorders and only a certain percentage of them got the effects.

It is now clinically observed that variation in the development of such stress diseases depends upon specific physical and mental constitution. Thus, persons of ectomorphic type of physical constitution and cerebrotonic type of mental constitution are more liable to develop stress diseases than others. However, these stress diseases can also occur in persons of mesomorphic and endomorphic constitution with somatotonic and viscerotonic types of psychic constitution provided the degree of stressful situation is strong and exists for a prolonged period. Thus, mental trauma in a person with sensitive nervous system for a shorter or longer period is the root cause of all stress disorders. In addition, the nature of a mental trauma and the circumstances under which it is produced may also influence the nature, course and severity of these disorders. There is evidence to support the idea that usually situations causing excessive mental conflict are likely to cause cardiovascular diseases. Similarly, psychological maladjustment in food intake may cause peptic ulcer, and sexual maladjustment may lead to one of the endocrine diseases like thyrotoxicosis, amenorrhoea etc.

It is interesting to note that many a time some patients suddenly get the disease after psychic trauma and later on by treatment quickly return to normal, whereas others get the disease after a prolonged exposure to stress and such patients do not regain their normal health for a long period. All these peculiarities appear to be due to varying psychosomatic constitution and also the type of stressful state one is exposed to.

PHYSIOLOGICAL AND BIOCHEMICAL CHANGES FOLLOWING STRESS

We have already observed that there is a considerable time interval between the occurrence of mental trauma and the onset of the disease. Sometimes it takes even six months or a year to develop the disease. This is probably due to the fact that the capacity to adjust to such disturbed situations varies from person to person. Some persons remain adjusted to such a situation for a long period and when their defence mechanism

fails, they develop the disease. Such a defence mechanism exists in the cells of the psychic centre of the cerebral cortex and when it fails, it interferes with the basic excitation and inhibition mechanisms of the brain. More usually it is the inhibitory mechanism which is upset by stressful situations leading to a continuous stimulation of centres of subcortical region by the cerebral cortex, especially the psychic centre of the frontal lobe. Such a prolonged stimulation of subcortical centres, i.e. those of the limbic system, hypothalamus with its autonomic nervous centres and reticular formation ultimately leads to excessive stimulation of various internal organs causing a disease in any one of the susceptible organs or organ systems. However, before the onset of disease in any organ or system, there is a clear latent period when signs of anxiety neurosis persist for a variable period of time. During the period of this "neurosis" several types of biochemical, physiological and morphological changes are seen. Bykov and his colleagues who had done considerable amount of work in this field, observed that histological changes occur not only in the size and shape of various structures in the neurons, but also in the various structural components of synapses. Further, they also observed changes in the capillaries surrounding the affected neuron not only of the cerebral cortex but also of the organs affected by the various stressful stimuli. Extensive investigations have been carried out on experimental animals and human beings after giving repeated acoustic stimuli. Such repeated acoustic stimuli produced marked changes not only in the higher nervous activity of the cerebral cortex, but also in the activities of the cardiovascular, respiratory, digestive, urinary, endocrine and other systems both in men and animals. Marked changes were also seen in the metabolism of carbohydrate, protein, fat, water and salts.

Biochemical studies of the brain tissue have indicated decreased activity of various enzymes such as cholinesterases, histaminase and mono-amine oxidase. As a result of it, there occurs an excessive accumulation of acetylcholine, histamine, catecholamine and serotonin in the various centres of brain causing disturbances in their activities. In addition, there

occurs an excess of cyclic AMP and a fall in ATP and creatine phosphate in the brain. From all these findings, it appears that, the nature and duration of anxiety neurosis preceding the development of stress disease depends upon the degree of biochemical, physiological and structural changes that occur in the cerebral cortex. It has been shown that soon after the stress exposure, there is a sudden release of acetylcholine from the cerebral cortex which activates all subcortical centres to initiate the adaptive response. This is soon followed by an increase in the activity of adrenergic and noradrenergic nerve endings in the subcortical centres especially in the hypothalamus. Subsequently, the activity of the neuroendocrine systems especially of the pituitary and the adrenal glands is enhanced. The main substance responsible for the production of stress reaction is the ACTH from the pituitary and cortisol from the adrenal cortex. These hormones affect the whole body including the cerebral cortex and induce a number of metabolic alterations.

BIOCHEMISTRY OF INITIAL RESPONSE TO NEUROSIS

Even after having all the above discussion we have not yet identified the main factor that actually triggers off the change in the cortical and other centres. It has now been well established from various physiological investigations and also from our own studies that psychologic stress, like any other type of stress produces excitation in certain specific cells of the cerebral cortex as a result of liberation of acetylcholine which causes nervous excitation in various cortical synapses and in the post-ganglionic endings of cholinergic fibres (Fig. 16). Normally, whenever acetylcholine is released into the synaptic cleft it is rapidly broken down by the enzyme cholinesterase. However, if the stimulus is very strong or if it is repetitive in nature, there is always a decrease in the formation of cholinesterase present at the synapses. Because of this, the excess acetylcholine is not destroyed. Such an excessive activation and liberation of acetylcholine in the cerebral cortex appears to be the main triggering factor in the genesis of all the changes

ACETYLCHOLINE RESPONSE TO PSYCHIC STRESS

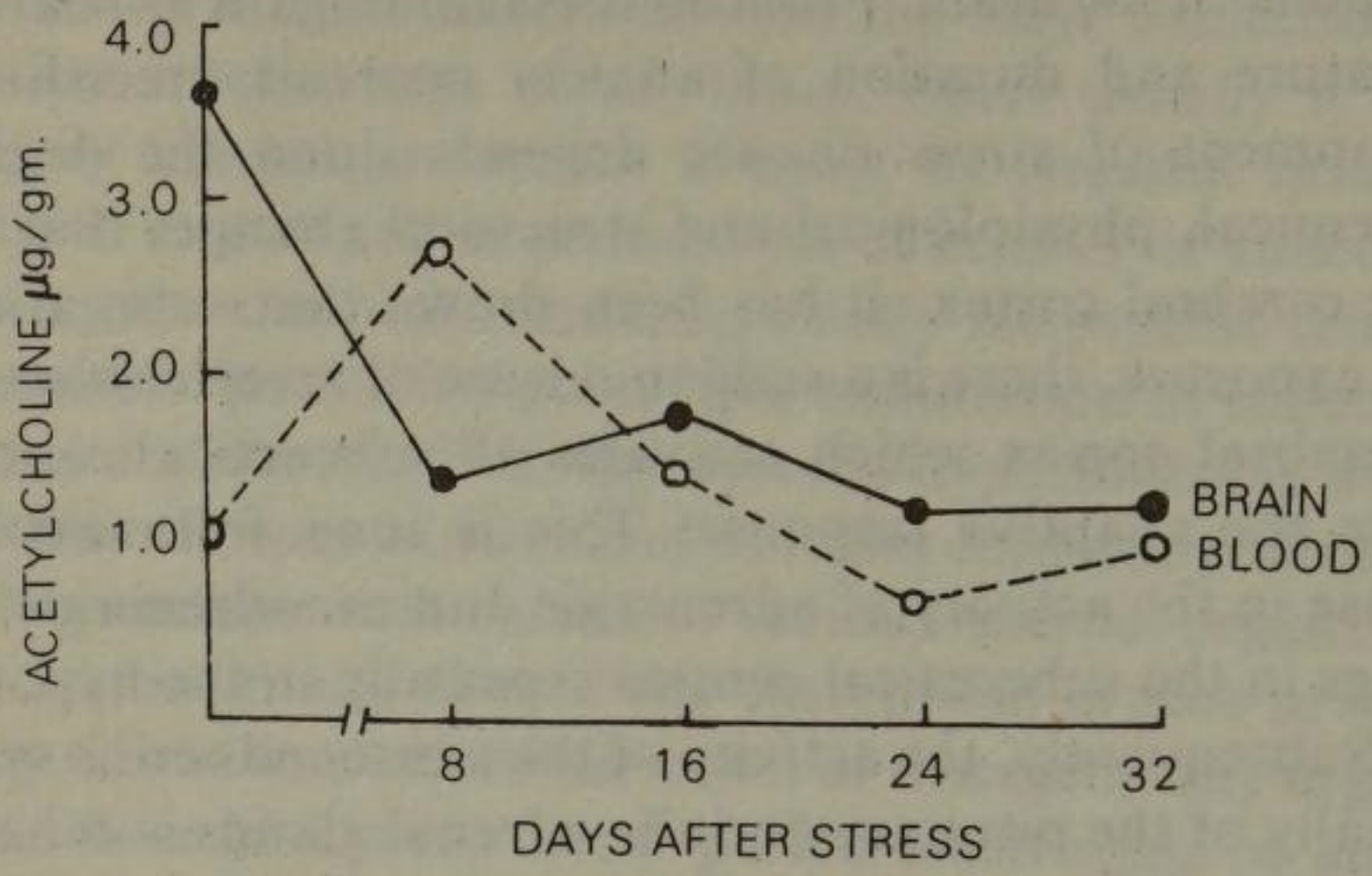


Fig. 16. Shows the response to psychic stress in the acetylcholine content of brain and blood in rats. Here one can see that stress causes marked reduction of acetylcholine in the brain coinciding with an increase in the acetylcholine content of blood. However, at later stages of stress both are found decreased.

that occur after psychologic stress. This biochemical change causes exhaustion of the inherent excitory and inhibitory functions of the cerebral cortex. In case such a state is allowed to continue, it produces after a shorter or longer latent period, a neurotic condition of the cells of the cerebral cortex which disturbs the functional relationship between the cortical and subcortical brain centres. As already discussed, the cerebral cortex through its excitory and inhibitory functions especially through the latter, controls the subcortical centres. If the inhibitory function is suspended and the subcortical centres are allowed to receive only excitation, the latter become hyperactive and produce not only marked excitation in their own function, but also in all linked systems such as the neuroendocrine system, the autonomic nervous system etc. Both these systems would ultimately excite all the internal organs and also all the other tissues leading to marked changes in the body.

The hypothesis regarding acetylcholine as the main initiating factor in the cerebral cortex has been studied by several investigators. Mitchel was the first person to observe through

PATTERN OF RBC ACETYLCHOLINE LEVEL IN DIFFERENT STREES DISORDERS

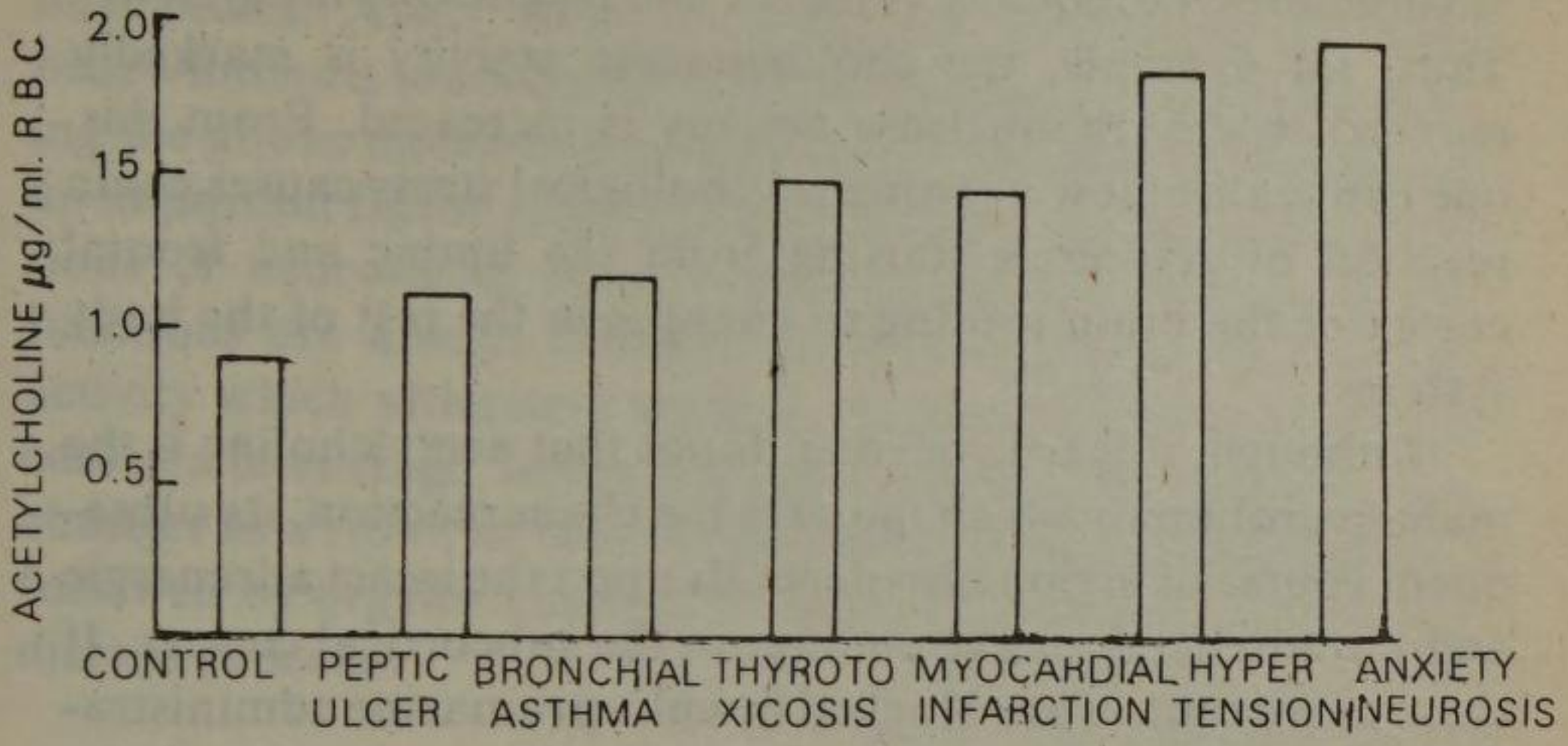


Fig. 17. Shows the changes in the acetylcholine content of blood in various common stress disorders. As one can see, anxiety neurosis has the maximum acetylcholine content followed by other common stress disorders like Hypertension, Myocardial infarction, Thyrotoxicosis, etc.

the Cup method that whenever there is an excitation of the cerebral cortex, there occurs a liberation of acetylcholine in abundance. Similarly, Kurtsin has reported that if acetylcholine is injected into the limbic cortex in the dosage of 2000 gamma through a previously prepared window in the skull, one could see the changes in the various activities of cortex and other centres after a lapse of 1 to 3 days which persisted for some weeks. We have also observed that acetylcholine is the first neurohumor which is liberated in an excessive quantity in the cortex following exposure to strong stimuli. In this connection Kurtsin states, "Hence, acetylcholine and no other mediator is the chemical agent which triggers the development of neurosis and cortico-visceral pathology while it is the limbic cortex that in psychic or some other cortical stress (emotional or interoceptive) overtaxes the nervous processes. The power of the 'Blow' produces severe disturbances of cerebral and visceral activity. Further, it also causes a prolonged after-effect lasting for weeks or even months (Fig. 17). This apparently contributes to the fact, that the strong stimulus entering the

brain 'smashes' the complex yet fragile structures made up of the neurons and their circulatory system and at the same time 'disorganises' the equally complex and fragile enzyme system". Thus, for example, the cholinesterase activity is markedly reduced, while ribonuclease activity is increased. From this, one can realize how a strong psychological stress causes chain reaction of responses starting from the limbic and frontal cortex of the brain leading to changes in the rest of the body systems.

Although, it is true beyond doubt that acetylcholine is the main neurohumor which initiates the chain reaction, its subsequent course of action also depends upon the intact adrenergic and noradrenergic nerve endings in the subcortical centres. If these nerve centres are blocked by chlorpromazine administration, not many changes of the neurotic type can be seen in the rest of the body. Therefore, in order to induce chain reaction in all the subcortical centres and their ramifications such as autonomic nervous system and neuro-endocrine system, not only does it need intact adrenergic and noradrenergic mechanisms,

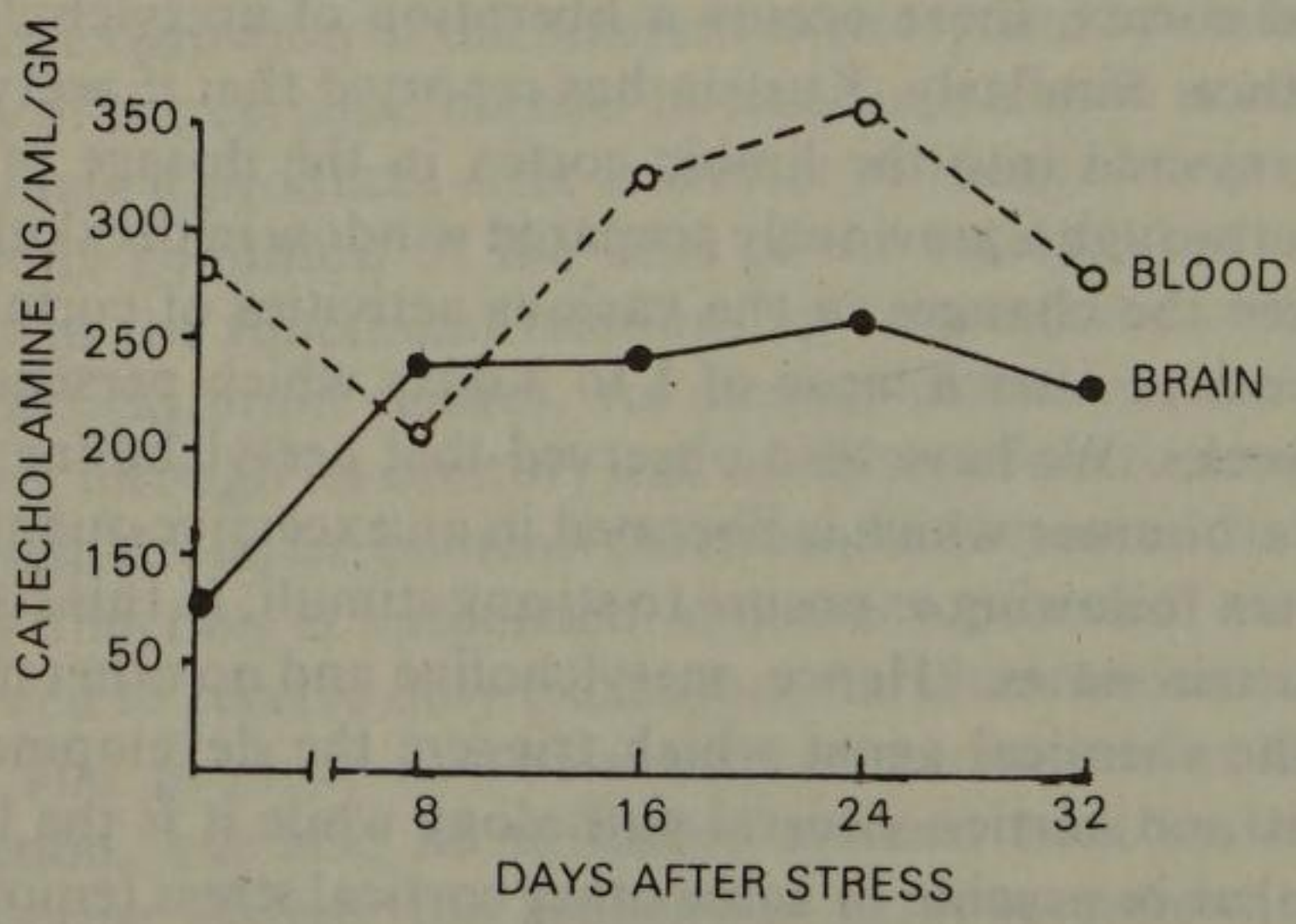


Fig. 18. Shows the catecholamine response in the brain and blood of rats. Here one can observe an increase in catecholamine content in the brain throughout the period of stress. However, in the blood at first there was reduction, then a rise followed by its normalization possibly due to the process of adaptation.

(Fig. 18) but also other neurohumors, such as serotonin, histamine, gamma-amino butyric acid (GABA) besides cyclic nucleotides. Apart from an excessive production of these neuro-humors, inadequacy of enzymes responsible for degrading the above mentioned neurohumors can also be considered an important factor responsible for causing various manifestations of neurosis in these subjects. Such changes in brain functions are always followed by alterations in the visceral activity which ultimately leads to the development of the disease at a later stage. In every organ, first there occur functional changes as a result of neurocirculatory overactivity, which are followed by organic changes leading to the appearance of the disease process.

CHAPTER 5

Stress and Neuro-Endocrinal Changes

Whenever there occurs a psychological or physiological stress, the entire psychosomatic apparatus of our body tries to adapt itself in order to face the external environmental challenges more effectively and successfully. To explain the facts two theories were formerly proposed, viz. 1. Pavlov's conditioned reflex theory, and 2. Selye's Hypo-physio-adrenocortical theory. But quite recently, both the theories have been merged and an integrated cerebrocortical hypothalamo-neuroendocrinal response is now supposed to explain all the changes that occur in a subject following any type of psychosomatic stress.

Historical background

Following any physical or mental stress, there occur two types of reaction: specific and non-specific. The specific reaction is directed towards maintenance of homeostasis. The non-specific reactions are common to all types of stressful state. In this, mainly through the pituitary-adreno-cortical axis, certain general responses develop in the body which Selye called "General Adaptation Syndrome." In this process there occur—(1) Marked enlargement of the Adrenal Cortex, (2) Involution of lymphatic system including thymus and spleen, and (3) Gastro-intestinal ulcerations and haemorrhages. All these changes occur in three stages—(a) In the first stage, which is known as "alarm reaction", the above responses are relatively in mild form and other constitutional reactions appear all of a sudden in an acute form. (b) This is followed by a "stage of resistance" in which most of the above changes are seen in a chronic form due to which the bodily defence forces are built up to adapt the

body fully to face the environmental stress successfully. (c) This is sooner or later followed by the "stage of exhaustion", if the stressful state continues for a long time and it may even lead to a fatal outcome if the attempt to adapt is not successful. In fact, the main purpose of the above reaction is to make an attempt by the body to restore the state of equilibrium and to maintain homeostasis.

Anterior Pituitary Stress Hormones

It is now well established that in response to stressful situation the anterior lobe of the pituitary gland vigorously produces ACTH and also to some extent growth hormone (GH). This leads to the stimulation of adrenal cortex which produces the necessary corticosteroid hormones. ACTH is secreted by the basophilic cells of the anterior pituitary and it stimulates the secretion of glucocorticoid hormones by the Zona Glomerulosa of the adrenal cortex which include cortisone, hydrocortisone, and cortisol. These hormones induce marked alterations in the carbohydrate, fat and protein metabolism in order to supply sufficient energy to all the cells of the body to face the emergency situations. They also cause atrophy of the thymus and of the lymph node, changes in the white blood cells, like neutrophilic leukocytosis, lymphopenia and eosinopenia. These hormones accelerate the absorption of glucose and lipids by the small intestine and increase gluconeogenesis and inhibit the glycogenolytic process. The secretion of these hormones varies in the acute alarm reaction stage. However, in the stage of resistance it remains high throughout. If and when the stage of exhaustion sets in, the rate of cortisone production becomes low due to which the subject ultimately succumbs to the fatal effects of stress. The second stress hormone of the anterior pituitary, namely the growth hormone, stimulates the production of minaralocorticoids, DOCA and aldosterone which regulate the metabolism of sodium, potassium, chlorides, calcium, phosphorus and iron. A prolonged use of these hormones produces Nephrosclerosis, Hypertension and inflammation in the joints and cardio-vascular system.

After stress all these changes occur in order to adapt the body system efficiently. Such a syndrome of adaptation, if it develops in an exaggerated manner, may harm and body by causing certain diseases of adaptation. Similarly, following excessive secretion of corticoids for a long period one may develop peptic ulcer, diabetes or atherosclerosis. Excessive production of mineralocorticoids may lead to the development of hypertension or nephrosclerosis. Thus, various genetic or environmental factors may also predispose a person to develop these diseases of adaptation. These factors may be genetic i.e. hereditary or constitutional or environmental such as diet, exercises, exposure to heat or cold.

All the above valuable observations were made by Selye during his experimental studies. Although Selye's observations are correct so far as the endocrinal response to stress is concerned, which is one of the important events, yet there appears to be a complete lack of correlation with various basic changes taking place in the nervous system and responsible for producing these endocrinal changes. It is only recently that he has agreed to revise his earlier views and now he has begun to realize that the stress reaction is not mediated directly through pituitary and adrenal cortex, but indirectly through the hypothalamus.

Hypothalamic Control of Stress

Hypothalamus modulates stress reactions through its various nuclei, especially the supraoptic nucleus which is the starting point for two pathways leading to pituitary gland. The supraoptic hypophyseal tract connects the above nucleus with the posterior lobe. This lobe is responsible for the secretion of ADH, vasopressin and oxytocin. The other is the humoral pathway of hypothalamo-hypophyseal system which connects hypothalamus with anterior pituitary through portal blood vessels. These nuclei in hypothalamus secrete various neurosecretions to regulate the function of anterior pituitary. Amongst them, the most important is the corticotropin releasing factor (CRF) which regulates the secretion of most of the

pituitary tropic hormones. Thus, the supra-optic nucleus of the hypothalamus stimulates the hypothalamo-hypophyseal system and produces corticotropin releasing and gonadotropin activating factors and simultaneously produces prolactin inhibiting factors. On the other hand, if the secretion of these releasing factors from the hypothalamus is decreased the secretion of tropic hormones from anterior pituitary is also reduced excepting "Prolactin" which is enhanced since it remains free from the inhibitory control of hypothalamus. However, hypothalamus plays an important role in producing various changes leading to efficient adaptation to stress, although hypothalamus is not an independent centre in the brain and its functions are closely regulated by the cerebral cortex. Now with the present knowledge, the reflex theory of Pavlov and the endocrine theory of Selye can be fully integrated.

Here let us briefly state how the stress reaction is triggered in the body. Whenever a stimulus is given to a subject, it is at first received by the peripheral nerve endings of the sensory apparatus. This nervous excitation proceeds along different nerve pathways to the respective brain centres like visual, auditory, tactile, gustatory or olfactry centres, where these sensory stimuli are analysed, integrated and synthesized. From here, the impulse proceeds to the psychic and limbic centres of the cortex to activate various adaptation mechanisms, so as to face the emergency situation effectively and also to maintain homeostasis. From here, the impulse passes to various subcortical centres, especially to the anterior part of hypothalamus to produce the neuroendocrine response discussed earlier. Thus, from this one can say that though neuroendocrine response plays its important role, the leading role in stress response is played by the highest division of the central nervous system, namely the cerebral cortex.

Other Endocrine Responses

ADRENAL CORTEX

It is now well established by Selye's work that various adreno-cortical hormones play a significant role in the adapta-

tion processes of the body. When an excess of cortisone is secreted, it does induce further changes not only in the body, but also in the activities of the nervous system itself, leading to further changes in vicious circle in the various parts of the body. Most of the studies on the effect of cortisone on various parts of the body were carried out by giving this drug in variable dosage and observing its effects. It was thus observed that the development of general adaptation syndrome is dependent upon the physiological state of the higher brain centres. Therefore, the degree of changes in the body is not only dependent upon the dosage of the hormone given, but also on the type of the nervous system involved. In smaller doses, cortisone stimulates the excitory process of the cerebral cortex, and if this is continued for a longer period it interferes with the inhibitory effect. However, if large doses of cortisone are given, it acts as extra-powerful stimulus to cortical cells resulting in exhaustion and inhibition. In this regard Kurtsin states: "Whatever the mechanism of hormonal action may be, it is clear that the nervous system which transmits the stress stimuli to the pituitary-adrenal system is itself affected by these hormones including ACTH, during the period of stress and that corticosteroids modify the activity of nervous centres and conducting pathways either directly or indirectly through reflex and humoral mechanisms. In this manner by the reciprocal influence of nervous and humoral factors under the leadership and guidance of the higher divisions of the CNS, a pattern of activity is established in the organism which is known as the general adaptation syndrome." From this, it is clear that it is the cerebral cortex which on receipt of stressful stimuli activates the hormonal mechanism of the adaptation process and the hypophysio-adrenal system is an intermediary link for the complex reflex reaction in various target organs and tissues.

It is also observed that the limbic system of brain is involved in the regulation of secretion of hypophyseal hormone and the development of stress reaction is largely dependent on the degree of influence exercised by the orbital area of the frontal lobe on the hypothalamus. On the other hand,

hippocampus exerts its constant inhibitory influence on the pituitary-adrenal system. Thus, whenever there is mental trauma or psychologic stress, at first the signs of neurosis develop, indicating thereby that there is disturbance in the activity of the cerebral cortex. This is followed by disturbance in gastric secretion, blood pressure and also increased secretion of corticosteroids. From all these findings one can say that the increased secretion of ACTH and corticosteroids which occurs in psychogenic stress is due to stimulation by the limbic system of the cerebral cortex. In addition to these important findings, there also occur changes in various other endocrine glands.

Changes in Thyroid gland

It is now well established that the thyroid gland plays an important role in stress reaction. Thyroxine regulates cellular respiration including that of central nervous system, internal organs, and muscles. The influence of cerebral cortex on tissue respiration follows two pathways: (1) Through nerve fibres: From the cortico-subcortical centres to the thalamo-hypothalamic region from where the messages pass through the sympathetic nerve endings to reach the cells, tissue and organs, and (2) through neurohormonal pathway: in this messages reach upto hypothalamus as above and from there through thyrotropic releasing factor to the pituitary which secretes TSH and thus the thyroid gland is stimulated. The thyroid releases thyroxine in adequate quantity to regulate tissue respiration effectively. Thus, the cerebral cortex regulates the activities of the thyroid gland and release of thyroxine. This function of the thyroid gland can be weakened by repeated superficial stimulation of the anterior part of cerebral cortex. Similarly, cerebral cortex is also affected by the excessive secretion of thyroxine.

In view of the above close relationship, whenever there occurs psychogenic stress, thyroid gland becomes overactive. Thus, in about 85% cases of thyrotoxicosis, a positive history of psychogenic stress is recorded a few days or months before the onset of the disease (Fig 19). In experimental animals also,

in response to stress, the weight of the thyroid glands increases while the diameter of individual follicle decreases. The disturbance of higher nervous activity with forced immobilization produces typical features of hyperthyroidism with rapid pulse rate, exophthalmus etc. It seems that in this process of hyperthyroidism the adrenergic fibres of reticular formation play an important role. In such a situation cortical influences are exerted indirectly also through the stimulation and release of adrenaline into blood. Thus, it appears that various manifestations of hyperthyroidism are due to increased secretion of both thyroxine and adrenaline. This phenomenon is obviously initiated by the cerebral cortex and is divided at the hypothalamic level. Similarly, the afferent informations from the thy-

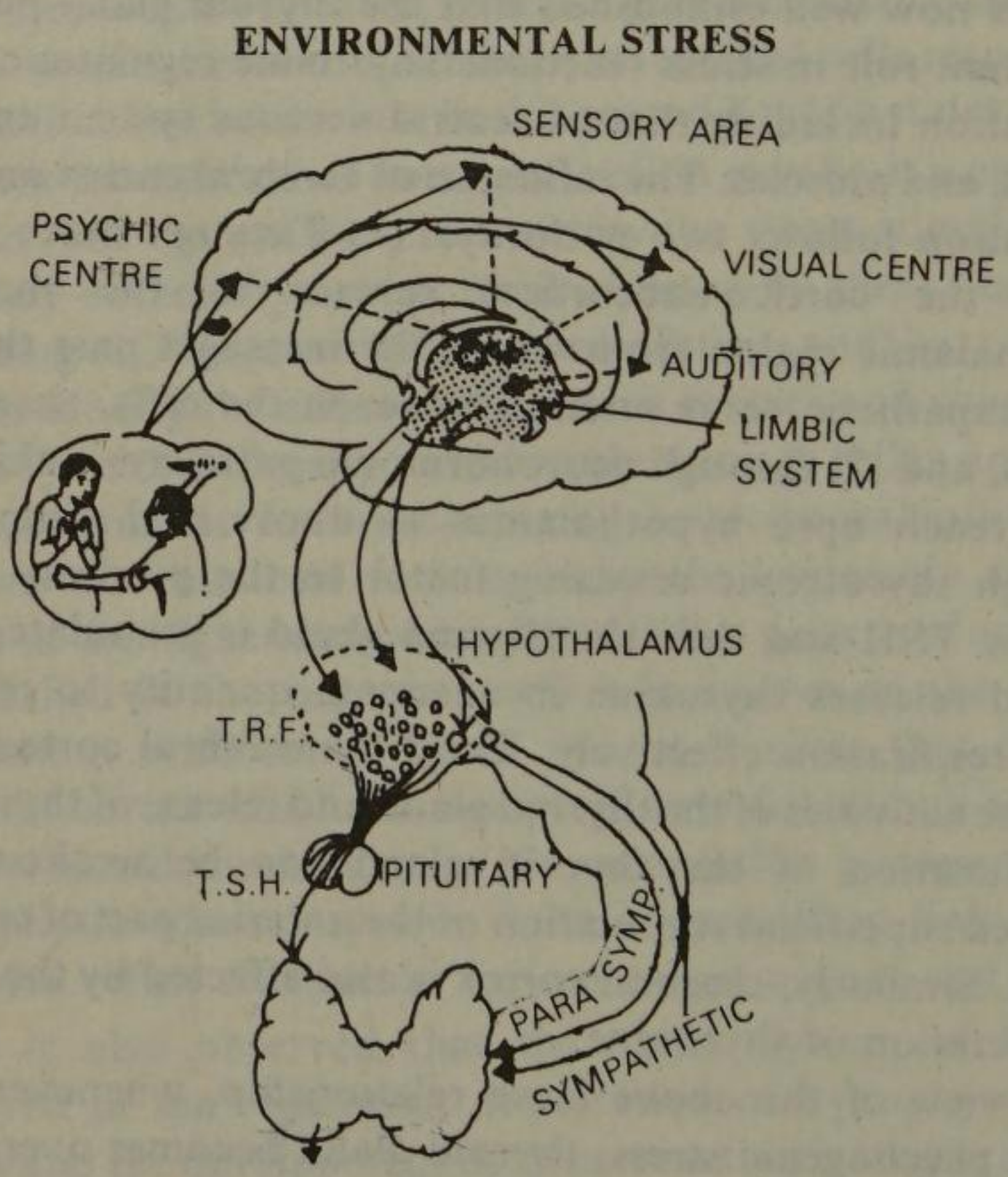


Fig. 19 Environmental factor in Thyrotoxicosis

roid gland reach the cerebral cortex through vagus and sympathetic nerves, the medulla oblongata and reticular formation. From the frontal area of the cerebral cortex there is a continuous feedback system through which the activity of the thyroid gland is continuously monitored and regulated. In psychogenic stress, excitation of a certain area of the frontal cortex (thyroid area) initiates responses, from where the stimuli reach thyroid gland through vagus and sympathetic nerves and also through the hormones via pituitary-adrenal system. Both these factors are responsible for stimulating the thyroid gland and act as intermediary link for producing various hyperactive changes in the tissues and organs including those of the nervous system.

ADRENAL MEDULLA

Waltor Cannon was the first person to propose that emotional stress causes excess of adrenaline secretion from adrenal medulla leading to tachycardia, high blood pressure, etc. Later, it was found that all these manifestations occur not only from adrenaline secretion but also from overactivity of the sympathetic nervous system which liberates noradrenaline at its nerve endings. These sympatho-adreno-medullary reactions can be blocked by adrenalectomy or by giving sympathetic blocking agents indicating that psychologic stress produces its effect through this sympathetic-adreno-medullary system also. Therefore, a person with severe stress shows marked rise in the circulating adrenaline and noradrenaline levels. Amongst the two, noradrenaline content is found raised when the person is in aggressive or angry mood without anxiety, and the adrenaline secretion predominates in a state of anxiety. From this is appears that whenever there is excess of cerebral cortical activity adrenaline will be found in excess and when only various subcortical centres are activated noradrenaline would be found raised.

ISLET OF LANGERHANS

It is now believed that the function of islets of Langerhans is also regulated by the cerebral cortex and that excess of psycho-

genic stress can interfere with its function and cause diabetes mellitus. Normally, messages from the cerebral cortex pass via parasympathetic centres of the hypothalamus to the vagus nerve which stimulates the islets. Whenever there is excitement, the secretion of insulin is increased as a result of vagus stimulation. However, when there occurs a prolonged stress, there occurs increased stimulation of sympathetic nerves with exhaustion of parasympathetic nerve endings leading to decreased secretion of insulin and consequent development of diabetes mellitus. This matter will be discussed further at a later stage.

POSTERIOR PITUITARY GLAND

Psychogenic stress also involves the posterior pituitary gland via the supraoptic nuclei of the hypothalamus. In stressful situations the cerebral cortex through its subcortical connection stimulates the posterior pituitary to put out more of antidiuretic hormone (ADH) which regulates the water and salt metabolism through its action on the renal tubules. Therefore, a prolonged psychogenic stress leads to the development of neurosis and, there occurs a disturbance in the kidney function resulting in the disorders of water and salt metabolism and disturbance in the urinary excretion. However, these changes in the urinary function should be taken as a result of disturbance of cortical function leading to changes in the limbic system, reticular formation and hypothalamus. The disturbance of ADH secretion should be considered only as a secondary manifestation resulting from prolonged psychogenic stress leading to development of neurosis.

EFFECT OF STRESS ON SEX GLANDS

Similar to all other endocrine glands gonads are also influenced by psychic stress. It is now well established that menstrual cycle in women depends upon the secretary activity of the anterior pituitary and ovarian hormones which are influenced by the higher centres of the cerebral cortex. Clinically, it is known that emotional disturbances influence the menstrual

function and libido also. The cortical centres mediate their influence through the hypothalamus which regulates the production of gonadotrophic hormone of the pituitary. It is known that there are two gonadotrophins, viz. FSH and LH. FSH stimulates growth of ovarian follicle and secretion of oestrogens in females and stimulates spermatogenesis in males. The LH controls ovulation and formation of corpus luteum in females, and in males it controls the formation of male sex hormone. Further, it also stimulates secretion of prolactin which induces lactation. Tumours of posterior hypothalamus cause sexual precocity and that of anterior hypothalamus hypogonadism. Prolonged psychogenic stress leading to disturbance in the activity of limbic system may lead to sexual disorders both in males and females causing impaired spermatogenesis and impotence in males and amenorrhoea and lack of libido in females. Thus, Kurtsin states, "It follows that higher divisions of the central nervous system govern the hormonal activity of the glands involved in the synthesis of the gonadotrophic hormones and oestrogens, as well as the estrous cycle, ovulation, spermatogenesis, reproduction, pregnancy and embryonic development. As a result, the hormonal activity is seriously impaired in psychogenic stress". From these observations one can say that higher nervous centres play very dominant role in the activities of sex gland throughout our life.

STRESS AND GASTRO-INTESTINAL HORMONES

It is now a well established fact that psychogenic stress affecting higher centres of the CNS causes disturbance in the formation and excretion of bile, both of which are normally under the control of digestive hormones such as cholecystokinin and secretin. Further, it was noted that adrenergic blockade of the brain stem causes alteration in the nature of bile secretion. All these disturbances in bile formation and secretion are exerted through the autonomic nervous system by the cerebral cortex. Same is the case with the hormonal regulation of exocrine pancreatic activity. Here, the influence of cerebral cortex on pancreas and the duodenum which pro-

duçe secretin and pancreozymes is also mediated through the autonomic nervous system. Similarly, psychogenic stress plays an important role in hormonal control of gastric secretion. Thus, dogs subjected to experimental neurosis suffer from disturbance of gastric secretion. In short, psychogenic stress produces profound disturbances in the synthesis of various digestive hormones leading to protracted changes in the secretary activity of different glands of GI tract and also in the functioning of muscle cells of the digestive system.

In general, endocrine glands, and their hormones fully participate in psychologic stress and hence, they act as links in the production of total psychosomatic disturbance. Psychologic stress first produces disturbance in cerebral cortex leading to disturbed regulation, integration and correlation of various external or internal stimuli received by it. This is soon followed by disturbance in the cortico-subcortical interactions. The ultimate result is that there occurs a serious disturbance in the functioning of hypothalamus leading to derangement of autonomic activity, homeostasis and metabolic function. In addition, there also occurs a disturbance in the functioning of endocrine glands particularly the pituitary, adrenal, thyroid, islet of Langerhans, sex glands and also the digestive hormones. Thus, from the hypothalamus, impulse reaches the internal organs by two pathways, one through the hormones via the pituitary gland and the other through the sympathetic nerves originating from the anterior and posterior sympathetic nuclei of the hypothalamus. Because of the impulse received through the sympathetic nerves and hormones, there occur changes in the cellular activity of the internal organs. These disturbed organs in turn send afferent impulses to the central nervous system and thus, aggravate the disturbance in the cerebral cortex and subcortical autonomic centres. Along with this, excessive stimulation of endocrine glands also leads to hyper- or hypo-functioning of one or more of these organs. Various clinical and experimental studies have shown that endocrine involvement of psychogenic stress is most commonly multiglandular. However, a particular endocrine gland

may have a major lesion, especially if the gland is already weak due to genetic or environmental cause. The cells of affected organs undergo many changes when studied ultrastructurally. These changes are seen most prominently in mitochondrias which are considered as microlaboratories where the process of oxidation takes place continuously when the excess of stimulation reaches the cells through hormones and the sympathetic nerve endings. When they release noradrenaline, there is an increased activity of mitochondria to increase the oxidation process. Because of this, mitochondria becomes hyperplastic and hypertrophic to face the increased demand of work. These functional changes are gradually replaced by organic changes in these internal organs because of changes in the vascular and neural patterns supplying these organs. The only way to improve the matter and to stop further deterioration in the condition is through blocking the afferent and/or efferent impulses to and from the central nervous system. Similarly, blockade of synaptic junction can also produce similar result. These results can be quickly gained by some of the recently discovered tranquillizers or gradually by a regular practice of Yoga and Meditation. This topic will be further discussed at a later stage.

CHAPTER 6

Psychological Factors and Stress Diseases

Various psychological factors play an important role in the causation of various psychosomatic diseases. Amongst them some might have been genetically inherited from parents, whereas others might have been acquired after birth as a result of various environmental changes. In addition, body constitution and psychic personality of an individual, which are the products of both inherited and acquired traits, also play important role in the causation of psychosomatic disorders.

Psychologically, a well adjusted normal person likes to be efficient, effective and flexible, and is able to profit from his experience of the past. If such a person is exposed to any stressful situations he faces them with reasonable amount of courage and then by adopting fight or flight response. As soon as the cirumstances change these emotional responses diminish and disappear. However, if a person is psychologically abnormal he will have too much of responses which would be unproportional to the stimuli and whose effects remain in the person for an abnormally long time. In such persons the abnormal responses are unpredictable and irrational. Many persons especially those who have an introvert personality, do not outwardly show that they are uncomfortable, tense or unhappy. Such persons' external behaviour may be completely different from what they feel internally. He or she may appear outwardly calm, but feels quite upset inwardly. It is these persons who are likely to develop most of the psychosomatic diseases. On the other hand, extroverts are less likely to be affected by psychosomatic diseases, though they are likely to face many controversies in their life which may lead to many visibly abnormal behaviours.

As already stated all these behavioural problems are due to genetic and subsequent environmental factors influencing life.

Genetic factors

Quite a number of psychosomatic diseases such as hypertension, diabetes mellitus, asthma, etc. are seen in the same families. However, it is difficult to establish that these diseases are genetically transmitted. There are no experimental methods by which one can establish these facts in animals. The only method by which one may be able to recognize these genetically transmitted traits is through the study of twins. Even here, many of these twins grow in non-identical conditions. The environmental factors cannot be completely ruled out.

It is now well established that each human cell nucleas contains 23 pairs of chromosomes arranged in a spirally twisted manner. Of these pairs, half are contributed by father, whereas the other half comes from mother. Each chromosome is composed of several jelly like parts called genes. These genes are composed of specific proteins attached to a vital substance called DNA (Deoxy Ribonucleic Acid). The total number of genes in each chromosome is not yet known, but the present estimate indicates that it may range from 40,000 to 80,000 in the 23 pairs of chromosomes found in a cell.

One is liable to inherit the physical and psychic characteristics of parents depending upon how many of these genes are dominant and how many are recessive. Dominant genes are powerful and hence they always show up their characteristics. The genes associated with recessive genes will not show their traits until they become paired with similar recessive genes. In addition to these two types of genes, there are intermediate and polygene types of genes which individually may not show their characteristics, but collectively may transmit certain specific traits genetically. In othr words, the presence of such polygenes may make a person more susceptible to get the disease under favourable circumstances. Thus, the inheritance of a number of faulty polygenes which predispose the person to a mental

breakdown in some intensive stressful situation is thought to be involved in the cases of schizophrenia. It seems that most of the psychosomatic diseases which are seen in many families might be having similar derangements of genes. However, these speculations need further confirmation.

Genetic influence on personality

Like bodily traits, personality traits also may be transmitted. Evidence for this hypothesis comes from animal and human studies. In the animals the study of intelligence, instinct, imprinting and psychological behaviour has given us a good amount of information. By cross breeding the animals having the same traits, one can gradually get highly intelligent rodents, aggressive rodents or fearful animals depending upon the choice. By similar experiments involving selective mating one can get an emotionally stable personality in dogs. These dogs can remain calm even after exposure to exciting circumstances.

Likewise, one can study the genetic traits in human beings in a family or in a given population. It is a known fact that certain bodily disorders such as haemophilia, Huntington chorea etc. are transmitted through defective genes in the families. In the same way certain mental disorders such as schizophrenia are seen in particular families indicating certain genetic background. Similarly, certain psychological traits such as mental deficiency, immorality, feeblemindedness etc. are seen in certain members of the families. Therefore, it is quite conceivable that the persons having the psychosomatic disorders may also have certain genetic susceptibility in them. Such a hypothesis has been confirmed by Axelrod and his colleagues. They studied the platelet monoamine oxidase, an anzyme which degrades catecholamines in patients with schizophrenia, and found it invariably low. Therefore, they felt that it could be a genetic marker for schizophrenic patients indicating that those who have inherited a genetic trait of low platelet monoamine oxidase in the family are more likely to develop schizophrenia. In our own studies, we found that this enzyme was low in many

patients with psychosomatic stress disorders, indicating genetic inheritance of this trait in these patients. However, this needs further study. It should be realized that such a low mono-amineoxidase in the body leads to defective degradation of catecholamines which may lead to their prolonged and harmful effect in vrious parts of the body. Depending upon the site of accumulation of catecholamines for a prolonged period the stress disorder makes its·appearance in that particualr organ or tissue.

By studying isolated population also, one may be able to locate the genetic traits, because in such isolated population, consanguineous marriages and inbreeding are very often seen. It was observed that in such families mental diseases such as schizophrenia and psychosomatic stress disease are more common. From all these studies so far conducted, one can say that the persons with the same blood relationship show a higher incidence of the same illness than is seen in non-relatives. Further, it was also observed that the closer the relationships, the higher was the incidence of such a disease.

These observations can be further confirmed in twins. It has been observed by many that twins brought up in different homes can still resemble one another to a high degree in temperament and personality indicating that both have inherited these qualities genetically. Similarly, the traits of extroversion and introversion in a person also seem to be transmitted genetically. Thus, genetic factors play an important role in producing various psychosomatic conditions and also psychosis. However, here one should not develop the impression that genetic disturbance is the only cause for the development of such disease, because, in most of these cases, the diseases develop by an interaction of heredity and environment. What is inherited is a predispostion to mental illness. Various environmental stresses serve to activate such a predisposition leading to manifestation of illness. Thus, it is possible that if a person is not exposed to such severe stresses he may remain symptom-free for years together. So in order to study the exact role of genetic factors and environment in the pathogenesis of various stress disorders one should make a detailed study of

various biochemical, neurological and psychological changes. Once these facts are fully studied one can make an attempt to prevent the development of such diseases as far as possible.

Pathways of Psychogenic Stress

While planning proper treatment, it is essential to know the details of the pathways through which psychogenic or other types of stress travel in the whole body to produce the disease. It is a well known fact that the external stimuli in the form of stress are received by the sensory receptors. In trauma the sensory nerve endings receive the message and carry it to the sensory cortex to produce the subsequent changes. The gustatory or olfactory receptors are not usually involved in stressful situations. In psychogenic stress it is mainly the auditory and ophthalmic receptors which are responsible for the initiation of stressful responses in the body. Thus, when a ghastly scene of violence involving a close relative is seen by a person who quickly registers a psychogenic response, the stimulus at first is received by the retina, from where the messages pass through the optic nerve to the visual centre in the occipital lobe. From here, the impulse travels along associated fibres of neurons to the limbic and psychic centres in the frontal cortex. Subsequently, it proceeds along efferent conductors to the hypothalamus from where it triggers the release of various hormones. Thus, the effect of the catecholamines and cortisol released from the adrenal gland in turn reaches the cortical and subcortical centres of the brain and produces further aggravation of the activity of the stimulated areas. As the pathological process advances and becomes chronic, the organs and tissues of the entire body are affected in the first instance. Thereafter, as the time passes with the same stressful situation any of the internal organs becomes involved in the disease process such as thyrotoxicosis, hypertension, bronchial asthma or peptic ulcer. The selection of one of the organs for involvement of this pathological sort depends upon various factors such as genetical predisposition and earlier life experiences. In a person who has developed susceptibility in getting stress response in the heart,

the stress wave of excitation is transmitted from the frontal cortex to the heart via pyramidal, frontopontine, paraventricular and ventromedial hypothalamus nuclei and then through vagus and sympathetic nerves. In addition, cortical inhibitory influence can also pass through the posterior hypothalamus to the heart via vagus nerve. From all these findings, one can say that there are two main centres in the brain where the major activities of stress take place.. They are limbic and frontal cortex of the brain which initiate all these activities on the receipt of messages from the various sensory areas and next are the hypothalamic centres by which neural and neuroendocrinal responses are organized and perpetuated throughout the period of stressful condition.

Amongst the two, cortical centres are the primary areas from where all these activities are initiated, and the hypothalamic centres are intermediary stations from where central ideas are put into action throughout the body through nervous and hormonal mechanisms. In response to stress, sympathetic stimulation leading to excessive production of adrenaline and noradrenaline is an important event. These hormones circulate in blood and cause further stimulation of nervous system and increase the activity of the cells of the peripheral organs. We feel that in this description one can integrate the theories of stress response propounded by Selye and Cannon. According to Kurtsin the integrated mechanism of action after stress would be as follows. The pathway may be stressor, sensory receptor, which ultimately goes to thalamus. From here the message can go down to the reticular formation or may go up to the cerebral cortex. Thereafter, the subcortical centres react to adrenaline, acetylcholine, histamine or serotonin, especially at the hypothalamus and reticular formation. From here the messages are transmitted to the spinal cord, sympathetic fibres, and then to the adrenal medulla to put out more adrenaline and noradrenaline. These hormones circulate in blood and again go to the hypothalamus and anterior pituitary and enhance the secretion of ACTH which further stimulates adrenal cortex to put out more corticosteroids into the blood. In addition to

adrenaline, messages to the pituitary and adrenal medulla can also be mediated through acetylcholine liberated by cholinergic fibres already present in these organs.

Stress leading to the development of general adaptation syndrome can be mild, moderate or severe. In the mild variety the wave of excitation is mostly confined to spinal cord and medulla. In this case, the stress reaction may be brought about by excessive secretion from adrenal medulla which further stimulates the pituitary adrenal cortex to put out more of corticosteroids. If the stimulus is severer than the earlier one, with reflex involvement mainly of thalamo-hypothalamic region, then the nervous structure is more involved and the excessive adrenocortical secretion is brought about not only by the catecholamines but also by the direct stimulation of the pituitary by hypothalamus. However, when the stress excitation involves cerebral cortex, as it happend after emotional stress, pain, fear or rage, this adaptation reaction is most extensive and the excitation process travels along the nervous and neuro-hormonal pathways to every part of the organs and tissues of the body to produce widespread stress reaction.

In short, one can say that in the development of general adaptation syndrome both the nervous and endocrine factors are involved. Amongst the two the first and more important is the nervous phenomenon which in reality is a neurohumoral phenomenon. Thus, Kurtsin states, "The important part played by various biological substances in the interaction between the nervous system and the pituitary-adrenal hormone system must also be borne in mind, particularly the mediators of nervous excitation such as noradrenaline, acetylcholine, histamine, serotonin, Dopa, polypeptides, unsaturated hydroxylipid acid, glutamate (which mediates the excitation in non-cholinergic cerebral synapses) and gamma-aminobutyric acid (which inhibits synaptic transmission). It must be assumed that they take part in producing the psychogenic stress reaction in the central nervous system, since on micro-injection into various parts of the brain acetylcholine and dicarboxylic aminoacids (mainly glutamic acid) were found to produce excitement, while monocarboxylic acids

EFFECT OF ELECTRIC SHOCK ON ACH CONTENT OF RAT BRAIN

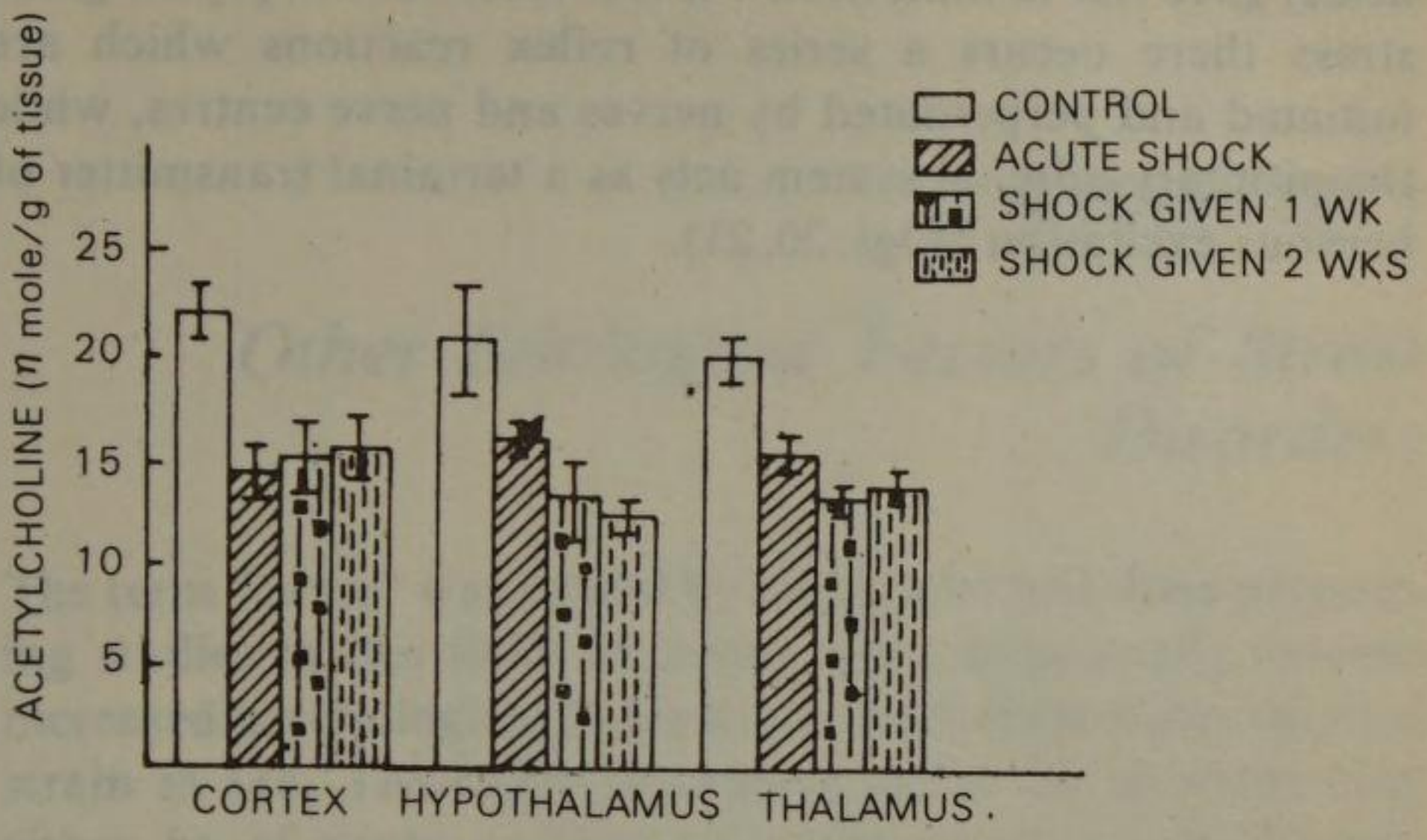


Fig. 20. Shows the effect of repeated electric shocks to rats for 2 weeks on the acetylcholine content of the brain. It is clear that the acetylcholine content becomes less by about 33% in the cerebral cortex, thalamus and hypothalamus.

URINARY 5-HIAA IN DIFFERENT DISEASES

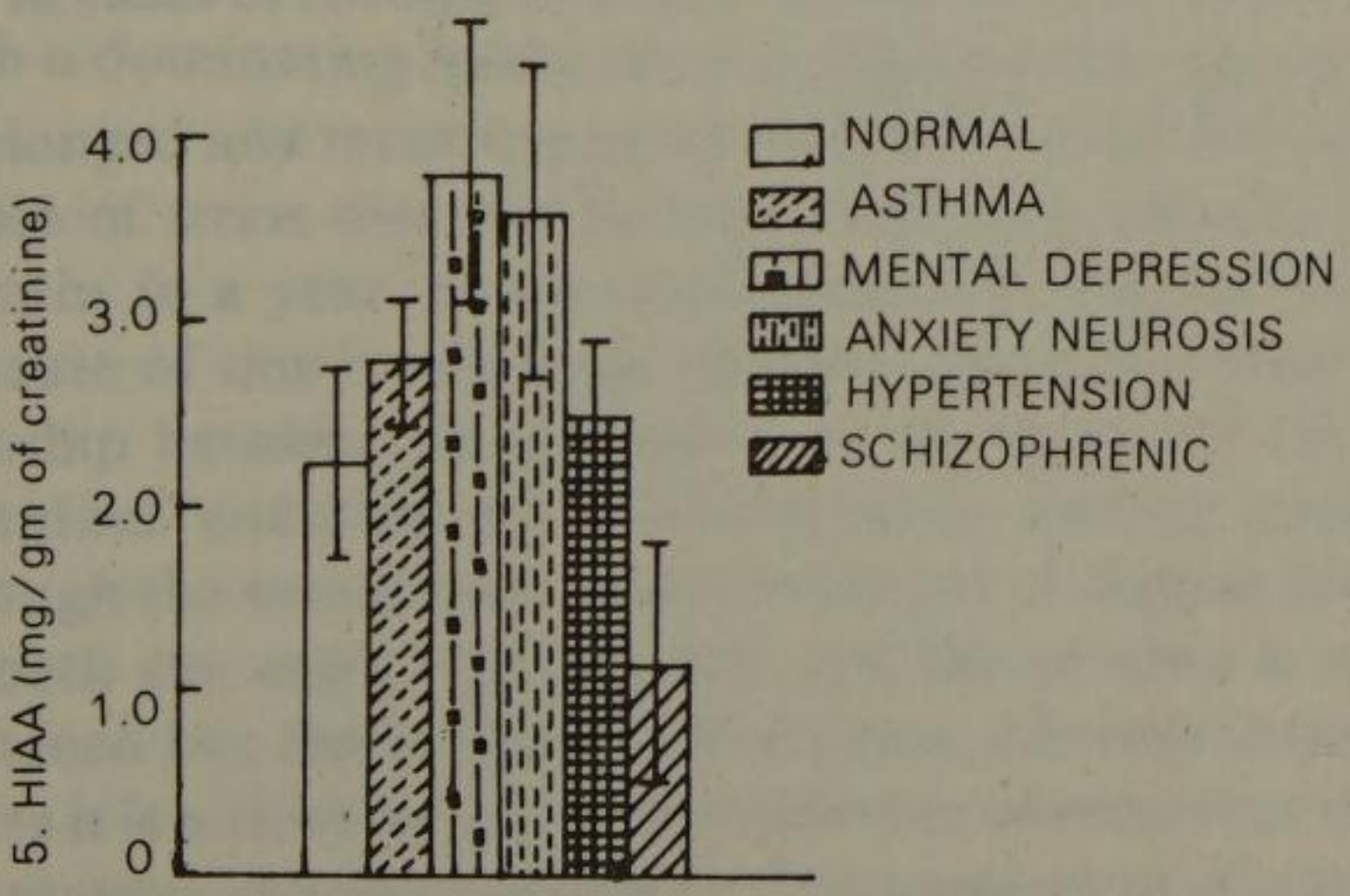


Fig. 21. The urinary excretion of 5-HIAA in different stress diseases. Note that in anxiety neurosis and mental depression there was a marked increase in 5-HIAA whereas in schizophrenia there was a marked reduction in the excretion of 5-HIAA, indicating its important role in these conditions.

(gamma-amino butyric, beta-alanine, and delta-aminovaleric acids) gave rise to inhibition". It is evident that in psychogenic stress there occurs a series of reflex reactions which are initiated and perpetuated by nerves and nerve centres, while the pituitary-adrenal system acts as a terminal transmitter of nervous excitation (Figs. 20, 21).

CHAPTER 7

Other Etiological Factors of Stress Disorders

The term "stress" was coined by Selye, who had done pioneering studies in this field for many years. It generally denotes increased psychological distress as a result of excessive nervous strain in life. The stress producing agents or stressors may either be of acute, sudden and severe type or of chronic, recurrent and milder type. A sudden demise of a close relative or a sudden loss of wealth or prestige in society usually leads to a quick succession of psychosomatic changes, leading to the development of one or the other of the stress disorders, like hypertension etc. within the course of the next 2 to 3 months or so. In cases of chronic recurrent stress, such as is seen in homes with a dominating husband or a nagging wife, one may have a prolonged and recurrent psychological friction before any evidence of stress disorder becomes apparent. Usually it takes 6 months to a year for the development of any symptoms and because of this many times patients may not realize the relationship between the stressful state of his or her life and the symptom complex that follows after leading such a life. Though the mechanism of development of disease is the same in both the cases, in the acute one the process is markedly hastened as a result of severity of stress, whereas in the chronic stress it is a slow process with evidences of recurrent stress and adaptation changes leading to development of disease after a long time (Fig. 22).

It is now a well established fact that all human beings do not respond in the same way to a given stimulus, because they have different psychic and bodily constitutions. It is also known that

LEVELS OF ANXIETY IN VARIOUS STRESS DISORDERS

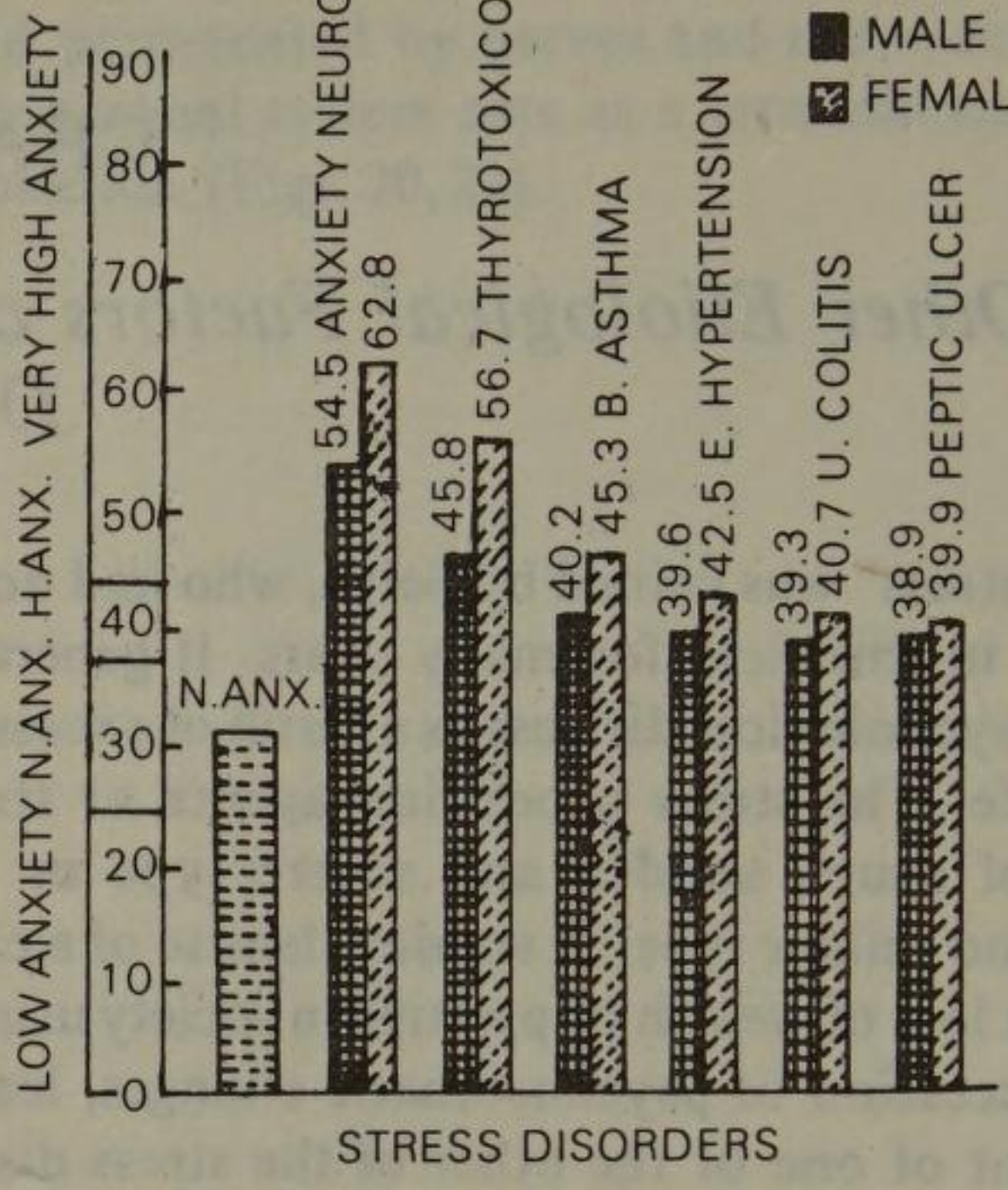


Fig. 22. Shows levels of anxiety in various stress disorders as estimated by psychological tests. It clearly indicates in all the stress disorders a higher anxiety score, the highest being in anxiety neurosis.

a person inherits these qualities genetically from his parents to a large extent. However, various environmental factors such as nutrition, climate etc. may play an important role in modifying these qualities to a considerable extent subsequent to birth. One should remember that environmental factors can be changed to a considerable extent by resorting to a congenial environment, but the inherited factors remain the same throughout life and they cannot be changed. Although in ancient Indian medical science great importance was attached to the psychosomatic constitution both in health and disease, in modern medical sciences very little work has been done in this field. It is only anthropologists who studied this problem at the beginning of this century. They divided human beings into three broad groups by the measurement of bony prominence. They designated them as Ectomorphs, Mesomorphs and

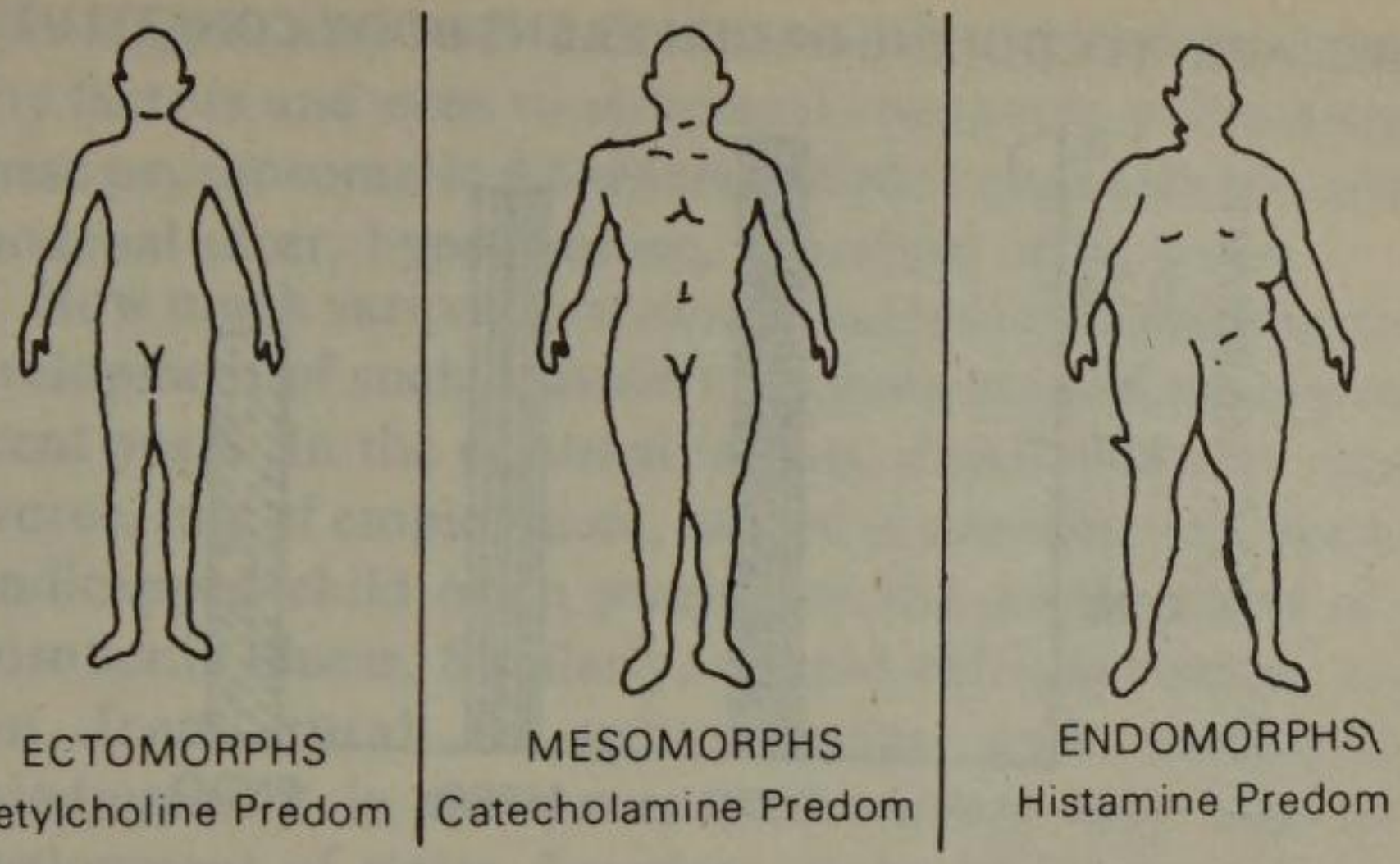


Fig. 23. Shows three types of body constitution as described by anthropologists. The authors of ancient Indian medicine described them as "Vata", "Pitta" & "Kapha" constitution. Our study indicated the predominance of acetylcholine, catecholamine, histamine and their degrading enzymes respectively.

Endomorphs according to the predominance of neurological, muscular or visceral activities respectively in these persons (Fig. 23). Psychologically also, such persons inherit a certain personality make-up which is likely to be influenced greatly by various environmental factors especially during childhood. In order to unify the concept of body constitution from the psychic and somatic point of view, we estimated the neurohumoral content of the blood of all these persons. We found that in ectomorphic constitution with neurotic temperament there is comparatively more of acetylcholine in the blood (Fig. 24). In mesomorphs with aggressive temperament there is more of catecholamine, whereas in endomorphic people with sober temperament there is more of histamine in the blood. Thus, it is now feasible to label these psychosomatic constitutions on the basis of neurohumoral predominance. A prior knowledge of these psychosomatic and neurohumoral constitutions would greatly help us to know as to how a person would respond to a stressful situation. Thus, a person with ectomorphic constitution when exposed to too much of stress, is likely to get more of

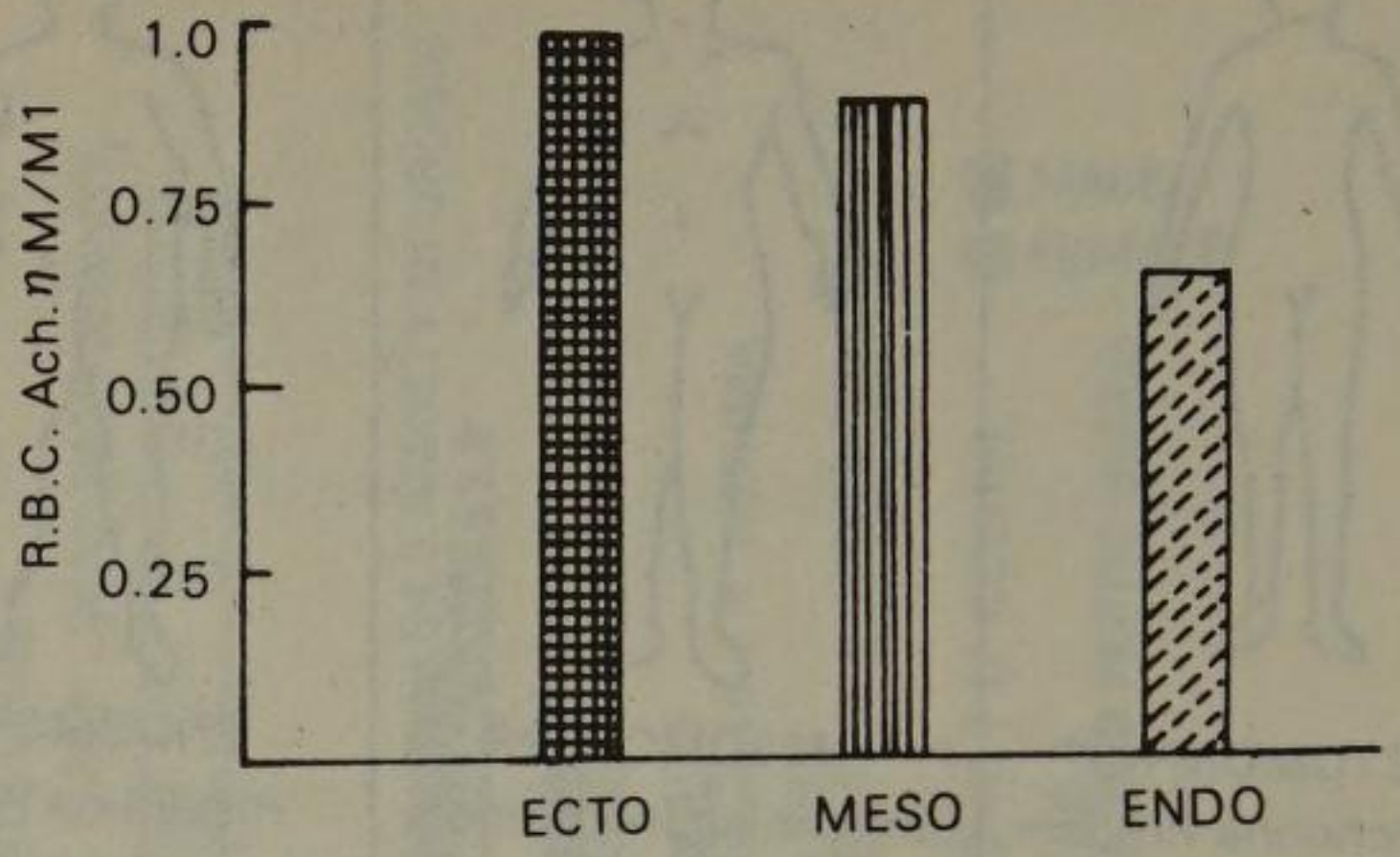


Fig. 24. Shows the acetylcholine content of blood in different physical body constitutions. It is clear that acetycholine remains high in ectomorphs, which is further confirmed by the finding of relative increase of cholinesterase in these people. These people are more liable to get neurosis after stress than others.

acetylcholine which may lead to the development of certain diseases such as chronic peptic ulcer in men, thyrotoxicosis in women, ulcerative colitis etc. Similarly, mesomorphs are more likely to develop hypertension or other cardiovascular disorders as a result of the excess of catecholamine circulation. The endomorphs who are genetically prone to liberate more of histamine during stress are more likely to develop allergy, asthma, or arthritis. However, all these genetic factors involved in psychosomatic constitution would be much influenced by different environmental factors during foetal growth or after birth. Many a time these environmental factors may completely overshadow the genetic factors.

Environmental Factors

It is well known that all stressful situations produce feeling of anxiety, depression, anger, frustration etc. and these feelings are usually associated with physical symptoms of palpitation and sweating, headache etc. In addition, these emotional states also produce autonomic, motor and endocrine changes which,

if prolonged, may lead to the interaction of genetic and personality factors and even to structural changes in various organs. These psychosomatic disorders include conditions like chronic duodenal ulcer, hypertension, bronchial asthma etc.

How much various environmental factors contribute to the development of such disorders has been studied extensively in recent years. In the personal factors, death of a near relative, divorce, loss of employment, failure in examination, birth of a handicapped child often precipitate the development of psychosomatic illness. Similarly, a rapid cultural change, migration from rural to urban areas and psychological maladjustment in the newer environment may lead to the development of stress disorders. Rahe had prepared a score chart for different types of stress in the family at the personal level, working place or financial positions. In addition, amongst the various environmental factors disturbances in nutrition such as undernutrition, overnutrition or malnutrition, play a significant role. Those persons who eat too much spicy food are more likely to develop chronic peptic ulcer, because their stomach is too often stimulated by the spicy food they eat from the very beginning. Hence, various enzymes which neutralize neurohumors become depleted at an early stage. As a result of it, the neurohumoral level especially of acetylcholine, catecholamine and histamine remains high leading to excess of gastric juice formation and ulceration in the mucosa. However, later on, in the presence of acetylcholine and histamine, catecholamines get themselves neutralized, though initially they do take part in the formation of ulceration by causing severe vasoconstriction. This can be guessed from the fact that in acute stress ulcers, there is a rise of all the three neurohumors. However, when the condition becomes chronic only acetylcholine and histamine remain high. Thus, it is clear that excessive intake of spicy food gradually makes stomach more susceptible to the excessive neurohumoral release especially of acetylcholine and histamine leading to chronic ulcer formation in the stomach or duodenum.

Similarly, excessive intake of fat and carbohydrates will make a person more susceptible to cardiovascular diseases as a

result of excessive fatty deposition in the blood vessels leading to atherosclerosis. In such persons, cardiovascular stress disorders are seen more commonly, which tend to become more complicated from the very beginning. Similarly, overnutrition, especially excess of carbohydrates is more likely to cause diabetes mellitus, because all the cells secreting various hormones and enzymes required for the breakdown of these sugar materials become exhausted in the early stage of life, leading to incomplete combustion of this food and then to diabetes mellitus. Lack of physical exercise, as is generally seen in people of affluent society further aggravates the condition and the disease appears much sooner than normally expected. From this one can realize how important role nutrition plays in these cases.

CLIMATE

Climatic changes may also predispose certain stress disorders. Thus, vasospastic diseases such as Raynaud's disease, Burger's disease etc. are more common in cold climates than in hot climates. There can be many other examples of this.

HABITS

It is a well known fact that people with smoking habits are more likely to develop various stress disorders than others. It is a fact that nicotine absorbed from the tracheobronchial tree after tobacco smoking stimulates the production of neurohumors. But even then it appears that the susceptibility becomes disproportionate to the absorption of nicotine. This would indicate that tobacco smokers sometimes become somewhat hypersensitive to various stressors leading to many harmful effects. Similarly, alcohol and other stimulating substances also, can produce similar stressful reactions if used excessively, or for a long period.

OVERCROWDING AND NOISE POLLUTION

In the presence of too many people with much increase in the noise level, such as we see in the slum areas of big cities, one

can really become a victim of any one of the stress disorders much faster than others living in the secluded rural areas or in the well planned urban environments. Normally, overcrowding itself makes such serious psychological changes in the minds of people living there that they become highly sensitive and become very irritable. This is because of the fact that they are exposed to too much of visual and auditory stimuli throughout the day and most of the night. From the visual and auditory centres of the brain there is a continuous flow of impulses to other centres of the brain leading to the state of constant exhaustion. In such a state any further stimuli that may reach them will produce abnormal activity in these centres leading to abnormally excessive stimulation of different parts of the body. That is one of the main reasons why one sees many psychological and psychosomatic disorders in the city dwellers than what one usually sees in people living in the relatively calm rural areas.

OVERWORK

Excessive straining of the body and mind on any work, disproportionate to the capacity of an individual, will also make him liable to get stress disorder rather very easily. Thus, those people who have great ambitions and constantly try hard to get some quick promotion by their own efforts become the victims of such diseases. Similarly, if by showing utter disregard of one's own physical capacity one works too much, he is also likely to get a stress disorder of a more severe type much early. Further, when young students with comparatively less physical and intellectual capacity try hard continuously to attain a high grade in their classes under a threat from their parents, they are also more likely to develop such stress disorders.

These are some of the common environmental factors which can make people prone to get any one of the stress disorders. However, the question as to which one of these factors really contributes to the development of a particular disease, needs further investigation. Suffice it to say here, that

these environmental factors play a significant role not only in the pathogenesis of these disorders but also in the perpetuation of them throughout one's life.

Selective Lesion of an Organ

It is often questioned by many, as to why some people after psychic trauma develop cardiovascular diseases such as angina pectoris, myocardial infarction or hypertension, whereas others develop GI tract disorders like chronic duodenal ulcer, ulcerative colitis etc. or a respiratory disease like bronchial asthma or endocrine diseases like diabetes, thyrotoxicosis, amenorrhoea or impotence.

Quite a lot of discussion and speculation has already been done in this respect, yet we have not fully solved the problem. However, following are some of the views on this vexed problem which in fact needs much more study. Till recently, most of the people felt that constitutional, especially genetic or hereditary, factors may be responsible for a particular organ to be affected by the stressful stimuli transmitted to it from the cerebral cortex. However, these genetic factors have now been questioned by many. It is a fact that incidence of certain psychosomatic conditions such as duodenal ulcer or cardiovascular diseases is seen in certain families more commonly than others, whereas most of the patients of duodenal ulcer or cardiovascular diseases do not have any family history of such diseases. Hence, only genetic basis does not stand the test of what we see in the clinical cases.

Some workers feel that selection of a particular organ for lesion depends upon the type of emotional factor itself such as anger, fear or grief which may produce reaction in a particular organ or system. Thus, hypertension and tachycardia are the expression of rage or repressed anger. Similarly, bronchial asthma can be due to suppressed feeling and ulcer may be related to feeling of dependence. It is stated that some of these emotional feelings are mediated by the sympathetic nerves causing hypertension, thyrotoxicosis, diabetes mellitus and arthritis, whereas others are mediated through the parasympa-

thetic route causing peptic ulcer, ulcerative colitis or bronchial asthma. However, the relationship between the emotional factors and specific type of disease has not been accepted at all, since there seems to be no correlation between the two. On the other hand, Kurtsin is of the view that stress causes disease of a particular organ if that organ has been affected in a certain manner at some earlier period, say, during childhood. This would make that organ susceptible to psychogenic trauma to be selectively reflected on it at a later period. Thus, this theory attaches great importance to the acquired condition of an organ in earlier life for the development of a stress disease following general neurosis. From these observations, one can say that for selecting a particular organ for lesion after the initial neurotic state, the weakening of that organ occurs not only due to hereditary factors, but also due to traumatic influences on the organ preceding the psychogenic stress. But, one should agree, that the specificity of emotional disturbance itself is not of much importance because each individual possesses his own spectrum of emotions depending upon his way of life, his education, and experience in life, his work, living condition, diet and social relationship. A particular event in life may not produce much emotional change in some, whereas in others it may produce violent reactions. Therefore, emotional changes are based on individual susceptibilities and hence, the same type of emotion cannot produce similar diseases in all the people. However, these emotional conflicts can cause initial generalized neurosis but cannot produce specific disorders by themselves. Thus, Kurtsin sums up his view as follows: "(a) An acknowledgement of emotional factor as an etiological agent in psychosomatic disorders. (b) A denial of any connection between particular emotions such as anger, fear or grief and specific internal organs such as heart, liver or kidneys or functional systems such as the digestive and cardiovascular systems. In all probability the same emotion such as anger ultimately produces cardiovascular, digestive or respiratory disorders. A particular system affected in a given person depends not on the specificity of the emotions, but on their particular significance for the individual affected and on the

presence of a weak spot in an organ or a system of organs. This weak spot is probably produced by both general and local factors."

In addition, Kurtsin also postulated that such a weak spot exists not only in a particular organ, but also there may exist similar focus of earlier lesion in the corresponding area of the cerebral cortex which may become activated by any type of stressful stimuli at a later date. Therefore, the earlier disturbance in the cerebral centres corresponding to that organ equally plays an important role in addition to the earlier local lesion in the organ in the development of a disorder. The existence of these cerebral foci has been extensively studied by various Russian workers in experimental animals. Thus, it is stated: "Hence, selective damage to an organ or organ system may be caused by over-taxing the central mechanism by which it is controlled. Psychogenic trauma is particularly likely to occur in an organ or system whose cerebral regulation centres have been overstrained".

The cardiovascular disorders which have been experimentally reproduced in monkeys at "Sukhumi monkey farm include hypertension, hypotension, coronary insufficiency and myocardial infarction." From these observations one can say that the selection for the development of stress disease can be due to an earlier lesion in the organ itself, or disturbance in the corresponding area of the cerebral cortex or both. Once the cerebral focus and the organ specificity is localized, further progress in the development of the disease depends upon the activities of various subcortical centres, especially the hypothalamus. To settle which one of the autonomic nervous systems becomes involved, sympathetic or parasympathetic, depends upon genetic and environmental factors. If the sympathetic nerves are overactive one gets hypertension and if parasympathetic nerves are stimulated the patient gets hypotension.

Similarly, one can judge these things by knowing the type of the lesion in each case such as hypersecretion or hyposecretion, hypermotility or hypomotility, vasoconstriction or vasodilatation etc. Therefore, the functional and organic

disturbance can be found out not only in the cerebral areas, but also in the affected subcortical centres and in the corresponding autonomic nerve endings supplying these organs. From these affected organs also, there is a constant feedback to the cerebral cortex leading to a vicious circle system throughout the period. From these observations one can realize that in all these stress diseases, the mere treatment of local lesion of internal organ such as "peptic ulcer" may not give a lasting relief unless the corresponding foci in the cerebral cortex and their extension in the subcortical centres are also treated simultaneously. Our experience in cases of "thyrotoxicosis" clearly shows that if one treats only the hyperthyroid state, recurrence rate is very high. However, if simultaneously the cerebral foci are also taken care of, the rate of quick and successful remission is very high. Hence, from the above it appears that characteristics acquired during the life of an individual both in respect of an organ and the corresponding area in the cerebral cortex play an important role in the location of the lesion in an internal organ. Such a localized lesion occurs after the psychogenic stress has produced generalized neurosis.

Role of Vascular Factor in Stress Diseases

In addition to the disturbances that occur at the autonomic nerve endings supplying the organs, circulatory disturbances may also play an important role in stress diseases. As already stated, the cerebral cortex extensively uses the hypothalamus to regulate the activity of the autonomic nervous system. Apart from the direct supply, sympathetic and parasympathetic nerves also modify the functions of these organs through modulating their blood supply. It is now known that adrenergic nerves cause vasoconstriction to a given organ, whereas cholinergic nerves usually produce vasodilatation. Therefore, whenever the sympathetic nerves are stimulated after mental trauma, they restrict the blood supply to the organ concerned. Thus, lack of efficient blood supply especially after an exposure to mental stress, may cause angina pectoris, while lack of blood supply to the stomach may lead to hypomotility and

hyposecretion of acid gastric juice. However, all these disturbances of the blood supply to these organs are caused by the disturbance in the cerebral cortex, which controls the circulatory dynamics of our body through the hypothalamus and vasomotor centre in the brain stem. If such a situation occurs in the kidney leading to vasoconstriction of renal vessels, it may result into severe impairment of renal functions and may cause the development of hypertension through the mechanism of activating renin and angiotensin. In the initial period these changes remain for a short period. But as the stressful situation continues, these changes may become permanent causing severe hypertension and other related disorders.

In the gastrointestinal canal, prolonged disturbance of vascular supply in the form of periodical vasoconstriction and vasodilatation in various organs ultimately leads to liberation of tissue histamine in the organ itself causing severe vasodilatation, stagnation of circulation, disturbances of permeability of vessels leading to ulceration in these organs. It is felt that such circulatory disturbances play an important role in causing gastrointestinal ulceration following acute or chronic stressful situation. In the same way, circulation in the coronary vessels can also be brought down to stagnation which ultimately leads to the development of coronary insufficiency. However, all these changes though they occur in the affected organs, remain still under the direct control of the cerebral cortex which operates these changes through hypothalamic and hypophysio-adrenal system. Further, the autonomic nerves themselves can also produce marked changes in the functioning of these organs. Thus, in the pathogenesis of stress disorders such as in myocardial infarction these neuro-vascular factors play a dominant role. In fact, in stressful states the vascular disturbances in these organs develop almost parallelly with changes in their intramural autonomic nerve supply which is under the direct control of cerebral cortex. The combination of these factors ultimately induces various pathological changes in the given organs. Initially these changes are functional in nature and later on lead to organic changes. In case of endocrine glands which are richly supplied with vessels, such as

anterior pitutitary, thyroid, adrenals and sex glands, circulatory disturbances caused by neurosis may significantly affect the syntheses of hormonal substances and the rate of their liberation into the blood stream. In this regard Kurtsin states: "The experimental findings regarding disturbances of vascular activity in neurosis provide a physiological explanation of the etiology of certain functional disorders of the vascular system itself from the point of view of the cortico-visceral theory. Of particular importance in this case is the fact that they indicate the great importance of the vascular factors in the development of a pathological condition of the internal organs and in the maintenance of a pathological condition of the cerebral centres in corticovisceral disturbances."

Basic Factors of Stress·Diseases

Thus, the main basic factor in the development of stress disease appears to be mental trauma which produces overtaxing of the excitation and inhibition process of the cerebral cortex. Such a mental trauma can be very acute and severe or moderate but repetitive which cannot be tolerated by the cerebral cortex. Psychic trauma acts as a trigger mechanism, which ultimately leads to the development of stress diseases such as hypertension, ischemic heart diseases, peptic ulcer, ulcerative colitis, bronchial asthma, etc. Most of these diseases are caused by the disturbance in the environmental factors which stimulate the exteroceptors (sense-organs) to convey the excessive stimulation to the cerebral cortex. On the other hand, according to Kurtsin, there can be excessive stimulation of the cerebral cortex by the disturbed interoceptors due to some functional or organic disorder in one of the internal organs which may lead to the same process of development of stress disease. Accordingly in the majority of cases a history of mental trauma can be found, in a few cases there may not be any positive history and in such cases the latter process is most probably responsible for causing the disease. However, once the disease has manifested itself in the form of disturbance in the cerebral cortex the further course of the disease remains almost the same.

Since, for the development of all these phenomena the cerebral cortex is the main seat of disturbance, one should know more about its role in this regard. Thus, it is realized that the entire brain does not function in the same way, nor it is always possible to localize every bodily function in the cerebral cortex. One should nevertheless remember, that the cerebral cortex functions as an integral unit along with the subcortical centres. However, for practical purposes Kurtsin divided the cerebral cortex into three groups of cerebral centres with specific functions, viz. (1) Mental brain, (2) Somatic brain, and (3) Visceral brain. It is now known that the somatic brain which controls the action of voluntary muscles is situated in the motor area of the cerebral cortex. Visceral brain is connected with the activity of the autonomic nerves supplying the internal organs. They can be grouped together as their centres are situated in the limbic cortex, basal surface of the frontal lobe, hippocampus, and amygdaloid complex. Any disturbance in these regions would produce marked changes in the functioning of corresponding internal organs. There seems to be close collaboration between the nerves of somatic and autonomic nervous systems and many a time their afferent and efferent fibres pass together in the same tract. The centre for mental activity mainly remains in the frontal lobes which controls all our thoughts and consciousness throughout our lives.

In short, the posterolateral part of the cerebral cortex and its centres of visual, autitory, tactile and other sensory activities receive their messages from the external environment to produce the required synthesis and analysis of these stimuli. The anteromedial brain assesses these informations received by the posterolateral part, adjusts them as per the needs and uses them for planning programmes of action through its psychic centres in the frontal lobes. In this way frontal lobes play a dominant role and if any damage occurs to these lobes, the person fails to perform any of the higher intellectual actions. In this way the cerebral cortex carries on its function in a most complicated manner, and it needs extensive study to appreciate its full role in the activities of our life, which go on

continuously not only as a result of environmental stimuli, but also as a result of continuous influence by certain cortical and subcortical centres, such as limbic and hippocampal areas of the cortical region, reticular formation, thalamus, brain stem and hypothalamus of the subcortical region. It is these cortical and subcortical centres which keep the mind always alert and active throughout our life.

The mechanisms of action of the psychic, somatic and visceral centres of our brain are closely interconnected by efficient anatomical and physiological links. However, the psychic centres are more closely associated with somatic centres than the autonomically controlled visceral centres. Thus, a person can perform a complex muscular action by activating the voluntary muscles by his own will, but he cannot ordinarily influence his heart rate which is under the control of the autonomic nerves. However, it has been seen that by yogic practice one can also develop control over the visceral functions. This indicates that the connections between the pyschic, autonomic and visceral centres are there, but ordinarily they are weak. But they can be made strong by the practice of yoga and other similar measures. Thus, some people may develop psychosomatic disorders after stress, whereas others develop only somatic or autonomic visceral disturbances, and in still others there may only be some psychic or mental disturbances. All such variations in response to mental trauma are considered to be due to individual differences in age, sex, occupation, personality, education, early life experience, etc. This may ultimately lead to varying types of response, such as, some persons may become angry, whereas others may become happy after receiving the same type of stress, depending upon various factors mentioned above. These emotional factors which have their centres in the limbic system connect the psychic centres above and hypothalamus below causing autonomic visceral disturbances leading to development of psychosomatic disorders.

It is interesting to note that many a time initially psychosomatic disorders of internal organs take the form of periodic alteration of hypo- and hyperactivity. Such periodic alterna-

tions may last for a few days or weeks and sometimes even for months. These are more common in the stress disorders of gastro-intestinal canal such as peptic ulcer, ulcerative colitis etc. although they can also be seen in the manifestations of cardiovascular disorders. It seems that in the inital period of excitation of autonomic nerves, cholinergic nerves play a dominant role which is later on taken over by the adrenergic nerves. Therefore, in the initial period of functional disturbances there occurs periodical overlapping and predominance of cholinergic and adrenergic nerve activity leading to hyper-and hyposecretion of various internal organs. Later on, depending upon the genetic and environmental factors one of the two autonomic components settles down to produce the various pathological changes in one of the organs.

CHAPTER 8

Patho-Physiology and Clinical Aspects of Stress Diseases

Normally, an average person can tolerate a certain amount of psychic trauma without much disturbance. However, if it exceeds the limit of his endurance then various psychological changes take place. Normally, such a phase remains in the body for a short while. However, if it becomes recurrent in the form of a repeated psychic trauma, then one may observe some visible and demonstrable changes in the behaviour and personality of a person.

It is a fact that in a recurrent stressful situation there occurs increased activity of the cerebral cortex, especially of the psychic centre. This fact can be confirmed by the EEG changes and also biochemically by observing increased acetylcholine content of blood with a decrease in the acetylcholine content of brain. As a result of these changes the patient becomes more irritable and readily becomes a victim of sleeplessness, nervousness, worry, palpitaton and apprehension. He also develops fine tremors in the hands and becomes extremely nervous in the face of an emergency situation, such as appearing at an examination or interview. Such a generalized neurotic phenomenon with elevated level of anxiety scale and elevated blood acetylcholine content is the early feature of almost all the stress disorders. However, the duration of such a state of disturbance may vary from individual to individual depending upon genetic and environmental factors and also the nature and severity of stress. As the situation continues perceptibly it affects one or more of susceptible organs more than the remaining ones.

Psycho-Somatic Changes

As the acetylcholine content of blood increases, it stimulates all the organs and tissues of the body as evidenced by increased oxygen uptake of all the organs and tissues. However, those organs which ae highly sensitive react quickly and those which are less sensitive react slowly. The hypothalamic region of the brain with plenty of catecholaminergic fibres and the adrenal medulla normally react promptly and give rise to increased outpouring of catecholamines. They include noradrenaline, adrenaline and to some extent dopamine. Such a stimulation of the entire sympathetic nervous system causing stimulation of all the organs and tissues through circulating catecholamines is initially a very beneficial reaction for the survival of the person concerned Unless such stimuli are provided which accelerate the metabolic process and other activities of the organs and tissues, there would be complete inertia and inadequate activation of these organs. Hence, certain amount of stress and strain is essential for the healthy growth of the organism.

As it would be discussed later on, the catecholamines stimulate all the cells of the tissues and organs by activating the enzyme adenyl cyclase present in the membrane of each cell of the body. This adenyl cyclase activates the 3-5 cyclic AMP which in turn converts the ATP to ADP and releases energy. The energy thus released stimulates the functioning of each cell. Thus, endocrine glands release more of hormones and the heart beats more rapidly and forcibly. Because of the stimulation of smooth muscle fibres present in the blood vessels especially at the arteriolar level there occurs a generalized vasoconstriction leading to increased blood pressure. Here it should be remembered that moderate vasoconstriction along with moderate increase in the blood pressure is beneficial. In case this vasoconstriction becomes more severe due to excess or repeated stress, the cells may go into a state of anoxia. If such a state of anoxia with the above stated mechanism of activating adenyl cyclase system is repeated, it may lead to more harm to the cells than good. Therefore, it becomes

obvious that if the release of catecholamine becomes excessive or prolonged, it may have a harmful effect on the body by its vasoconstrictive and other similar actions. It is known that acetylcholine activates the cells through cyclic GMP and it is usually accompanied by vasodilatation and hence has very little harmful effect on the body. Catecholamine, on the other hand, may produce a situation in which the cells may be put into distress just as starving does to an overworked man. However, ordinarily the coronary and cerebral vessels are spared from these vasoconstrictive effects since they do not have alpha-adrenergic receptors.

Because of these potentially harmful effects of catecholamines, there are many bodily mechanisms through which the excessive actions of catecholamines are quickly neutralized.

(1) The acetylcholine which initiates the release of catecholamine may become less active, and as a result of it, the continued stimulation for the secretion of catecholamine may become less. Similary, acetylcholine can also physiologically antagonize the action of catecholamines by counteracting its function through the parasympathetic nerve endings.

(2) On the other hand, biochemically, the catecholamines may be degraded by MAO (Monoamine Oxidase) and COMT (Catechol-O-Methyl transferase). If these enzymes are not synthetized in sufficient quantity, the action of catecholamine may remain high in the body or in any one of the specific organs. Such a high content of catecholamine for a prolonged period can inflict many damaging effects on the organs. However, if these enzymes are found in excess, it may indicate an increased turnover of catecholamines in these organs, indicating again a harmful effect. Hence, the estimation of catecholamines alone may not be of much value unless their turnover studies are also conducted by estimating the related enzymes to assess the activity in a given organ.

(3) In all the body tissues and organs there are also some putative neurohumors in the cells which are released into circulation whenever there is a stimulus, such as excessive sympathetic activity. These are histamine, serotonin and prostaglandin E. Histamine is a known vasodilator of the capillar-

ies and hence works as a powerful agent for antagonizing the vasoconstrictive action of catecholamines (Fig. 25). It is normally released by the mast cells present in the tissues. But the histamine has also been found at those places where there are no mast cells such as the brain. Therefore, it is postulated that histamine can be produced by all the body cells by utilizing the amino acid Histidine present in the cytoplasm. Similarly, serotonin also can antagonize the action of catecholamines in certain localized areas, such as the Raphe nuclei of the brain to a certain extent. However, serotonin may not be available in abundance in all the other areas where catecholamines are formed and hence this may not be as effective an antagonist as histamine. Recently, it has been postulated that even prostaglandin E might antagonize the action of catecholamine in the tissue especially with regard to its cardiovascular mechanism. It is stated that prostaglandin E causes vasodilatation and hence it is capable of neutralizing the vasoconstrictive effect of catecholamine. However, this aspect needs further confirmation. Summerizing the above statements, it appears that the main agent which neutralizes the vasoconstrictive action of catecholamine is histamine which is found throughout the body, though the other two agents, serotonin and prostaglandin E, may also contribute to some extent.

BLOOD VESSEL RESPONSE TO NEUROHUMORS

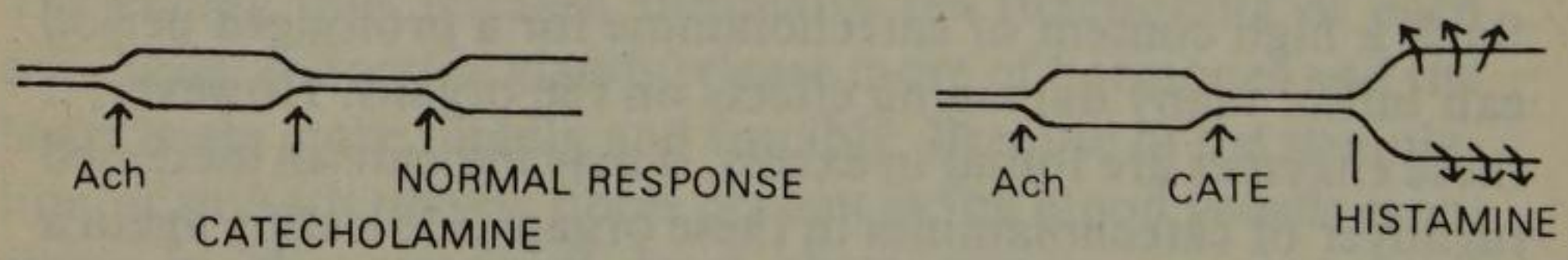


Fig. 25. Shows the effect of catecholamines in the microcirculation of organs and tissues. Normally, when the stimulus is mild, acetylcholine causes mild vasodilatation. As the effect of catecholamine dereases, normal circulation is maintained. However, if the stimulus is severe there is excessive vasoconstriction followed by liberation of histamine locally which produces marked vasodilatation leading to severe vascular engorgement, oedema and swelling in the region.

(4) Metabolically, insulin is a powerful agent which neutralizes the action of adrenaline. It is well known that adrenaline increases glycolysis, gluconeogenesis and lipolysis. Thus, adrenaline causes hyperglycaemia, hyperlipaemia with increased free fatty acid, total lipid and cholesterol contents of blood and increased protein breakdown. On the other hand, insulin just reverses all the actions of adrenaline such as glycogen synthesis, lipid deposition and protein anabolism, if given in physiological doses. Hence, insulin is also a powerful metabolic antidote to catecholamines in the body.

(5) To a certain extent cortisone also antagonizes the action of catecholamines especially the vasoconstrictive effect of noradrenaline by improving the microcirculation of the tissues and causing vasodilatation. Thus, one can see from this that though following all types of stress there occurs increased outpouring of catecholamines, there appear to be many physiological and biochemical mechanisms in the body which if present in optimum quantity fully neutralize catecholamine. If these safeguards are not present in any organ or tissue either due to genetic or environmetnal factors, the excess of catecholamines may produce harmful effects especially in the middle-aged and elderly persons. Once these catecholamines are found increased in blood or body tissues, they gradually settle down to one of the systems or glands of the body to produce its damaging effects. Why and how such a selective damage to a particualr organ takes place in a given individual is an important subject which needs further discussion and investigation.

Weak Organ Phenomenon

It is now well known that out of a large number of people who are exposed to excessive amount of stress, only a few become the victims of some type of stress disorder, because others gradually become well adapted to such a situation. They commonly do so by having developed sufficient neurohumoral degrading enzymes in the body and also other antagonizing mechanisms to quickly get over the respective neurohumors produced in response to repeated stress. Even in those few who

develop such stress disorders, there is no definite means by which one can predict which one of them would develop what type of stress disorder and under what circumstances. Further, it is not at all clear as to which one of the organs or tissues would ultimately become a target of one of these stress disorders and what are the factors which would determine such a localization.

As already discussed, one of the guidelines is that genetically the type of psychosomatic constitution may predispose people to get a particular type of the disease, but there are many variations and exceptions to this and it can at the best be only one of the many factors. In addition, there are a few other evidences to indicate that one of the important factors which determine the localization is the amount of neurohumoral secretion such as acetylcholine or catecholamine that occurs following a stressful situation. It is known that these neurohumoral secretions depend upon the number of actively secreting cholinergic fibres and catecholamine secreting nerve endings (adrenergic and noradrenergic fibres) in a given organ and also the number of mast cells present which are responsible for the secretion of histamine. Similarly, the capacity of the organ for producing degrading enzymes of the respective neurohumors may also determine whether that organ is likely to be the target of the stress disease. For example, if genetically there is excess of actively secreting noradrenergic fibres in thyroid gland with a minimum MAO producing cells, then that thyroid gland can become a target of thyrotoxicosis due to excess of catecholamine. Similarly, after birth if for some reason or the other, as discussed earlier, an organ has been put into lot of stress such as the stomach, there is every reason to believe that it is a weak organ in that person, and hence, his stomach would be the first organ to be affected by excess of acetylcholine whenever it exceeds the stress threshold of that person. Therefore, it appears that the stress disorders localize in a given organ partly due to genetic weakness and partly due to weakness acquired after the person has been born and brought up. Even amongst the two possibilities various envir-

onmental factors, especially nutrition and other related factors, play a greater role than others.

Autoimmune Phenomenon

Following stress catecholamines are mainly responsible for producing some of the main biochemical and pathological changes. Amongst the various actions of catecholamines, the vasoconstrictive effect of noradrenaline produces many pathophysiological changes. It is well known that whenever there is complete vascular blockade due to thrombosis, there occurs infarction in that organ. However, if recurrent temporary vascular blockade occurs due to severe vasospasm at the arteriolar ends as a result of excess of noradrenaline, it gradually produces chronic ischaemic changes such as patch necrosis, atrophic changes or fibrosis in that organ. In such a situation with recurrent temporary ischemia some of the necrotic materials from the affected cells which may act as hidden antigens are absorbed by the local region through vessels and lymphatics and are carried to regional lymph nodes. Here, these antigenic materials evoke the formation of antibodies by the plasma cells and macrophages present in these lymph nodes. When such antibodies again come in contact through lymphocytes in the blood with the antigenic materials present in the affected organ, there occurs a typical chronic inflammatory reaction. In this process the lymphocytes and plasma cells take a dominant role in producing the antigen-antibody reaction. If this process is allowed to continue for a long time as a result of continuous stress, then there occurs a gradual destruction of the parenchymatous cells of that organ by the immunologically competent plasma cells and lymphocytes. One can observe all these autoimmune changes very clearly in case of chronic thyroiditis and certain types of thyrotoxicosis. But such changes can also be seen under similar circumstances in all the organs with stress diseases. Gradually, as the disease progresses under the continued stressful situations with recurrent incidence of catecholamine release and vascular insufficiency, more and more areas of the organs become involved with autoimmune changes.

Many a time one can observe a kind of periodicity in these changes directly related to psychosomatic stress. Normally in the inital period there occurs hyperactivity in these organs followed gradually by hypoactivity. Initially these changes are so insidious that the patients usually do not realize the impact of the damage, unless the changes appear more abruptly or in greater severity. These chronic inflammatory and autoimmune changes are followed by healing, then there occurs fibrosis in some of the organs, which may itself lead to many complictions. Thus, autoimmune thyroiditis would ultimately lead to hypothyroidism and myxoedema. Bronchial asthma is gradually followed by permanent narrowing of the bronchi which would lead to emphysematous changes. Chronic peptic ulcer and its healing process may lead to pyloric obstruction. Chronic ulcerative colitis may be followed by lead pipe type of colon. Chronic arteritis gradually leads to atherosclerosis, hypertension, thrombosis and haemorrhage. Thus, coronary thrombosis or cerebro-vascular accidents are nothing but the sequelae of stress disorders of these affected organs. In all these stress disorders there is initially increased catecholamine level leading to all these autoimmune phenomenon and healing in some form or the other which further leads to some of the above mentioned complications. Since some of these changes are also seen in the aging process, what usually occurs as a result of stress and strain of life can be called as nothing but a hastening of aging process resulting in so called premature aging and resultant atrophy of the vital orgns in relatively early age.

Four Phases of Stress Disorders

There are thus four distinct phases in the development of stress disorders—

(1) Psychic Phase,
(2) Psychosomatic Phase,
(3) Somatic Phase, and
(4) Organic Phase.

In the psychic phase the person gets most of the psychological changes as a result of excessive psychic trauma. Repeated and excessive psychological onslaughts from the people around him either at his residence or at his place of work make his central nervous system overactive. He becomes very irritable and hyperactive and may develop mild tremors in his limbs. Sleep is disturbed and he becomes more anxious than before. He looks worried and anxious and he always thinks of some impending disasters. All these features can be subjectively measured by using anxiety scales and objectively by estimating acetylcholine content in the blood, which is usually found much more increased than normal. Depending upon the type of personality and body constitution, and upon the type of stress phenomenon, the persons continue to undergo these changes for a period ranging from a few days to a few months.

If the same situation continues, the patient goes to phase two of this phenomenon, namely the psychosomatic phase. At this stage along with the above stated functional disturbances one can also notice certain generalized changes such as hypertension, tremors, palpitation, etc.

In the third or somatic phase one can notice an increased function of all the organs, especially of target organs. Thus, some features of hyperthyroid state can be seen if the thyroid is the affected organ. Similarly, tachycardia and hyperchlorhydria can be observed if heart and stomach are the target organs respectively. Thus, in this stage gradually one can surmise which one of the organs is going to be affected in this process. As already stated, the stress disease usually settles in an organ depending upon the sufferer's hereditary background and also on the environmental factors. Hence, along with various manifestations of stress, there may be evidence of increased catecholamine secretion which can be confirmed by estimation of catecholamine during the period of organic hyperfunction. Many a time symptoms are seen in paroxysms and hence catecholamine estimation should be done at the height of manifestations. At this stage, along with an increase in acetylcholine, there will be an increase in the catecholamine content

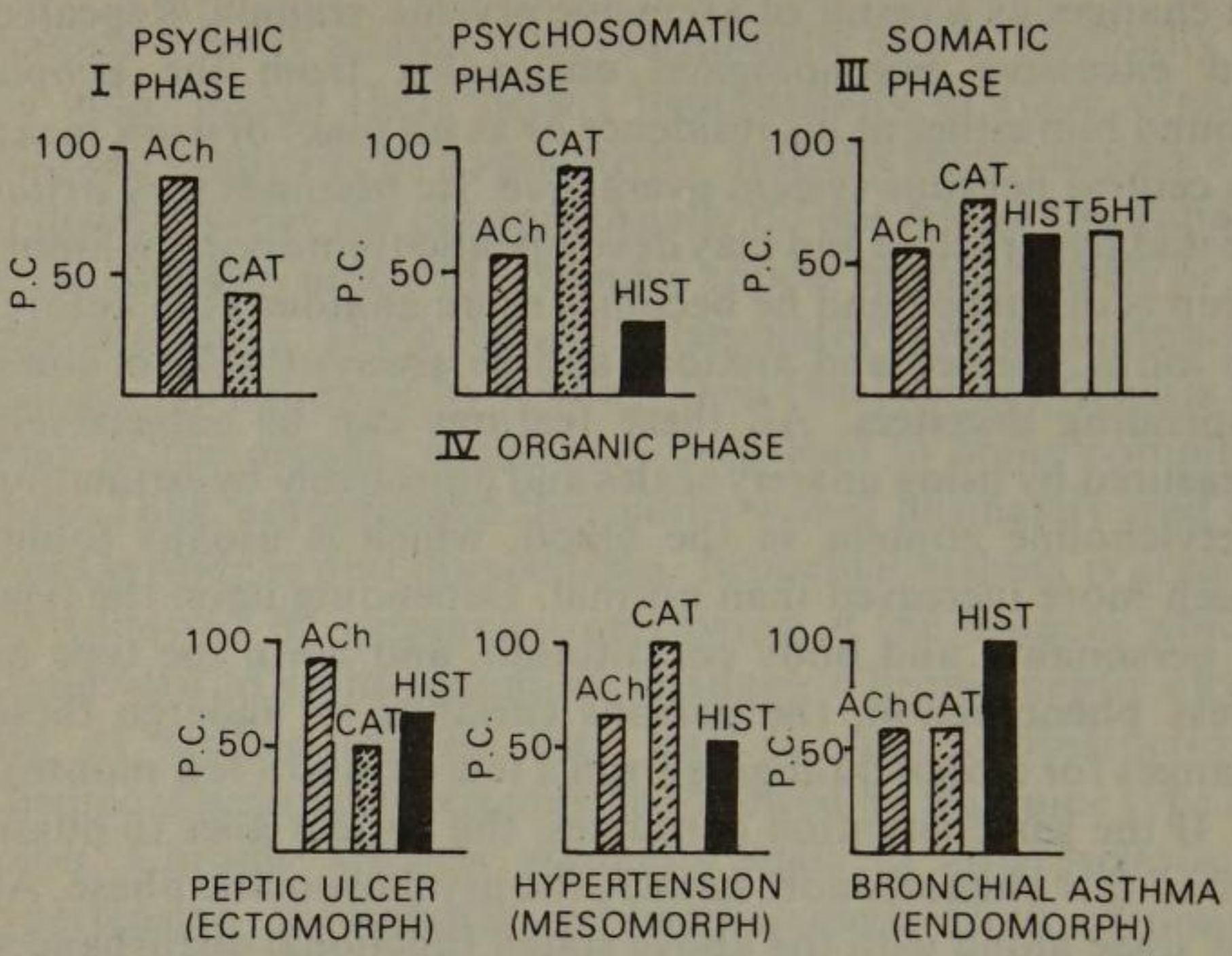


Fig. 26. Shows the neurohumoral pattern in 4 stages of development of stress disorders. In the first, with psychic disturbances there is increase only of acetylcholine in the blood. In the second or psychosomatic phase there is predominance of catecholamines indicating sympathetic overactivity. In the third or somatic phase, all the neurohumors increase in the blood. In the 4th or organic phase the disease localizes in one of the weak organs, as determined by somatic and environmental factors. Thus, one can see in peptic ulcer more of acetylcholine, in hypertension more of catecholamines, and in bronchial asthma more of histamine.

along with its degrading enzymes, which would indicate more turnover of it during this period. (Fig. 26).

At the fourth stage, gradually the lesion settles down in the target organ with full-fledged autoimmune phenomenon in the form of chronic inflammatory changes. Gradually, many a time the features of psychological and psychosomatic phenomena subside as the disease fully settles down in an organ. Hence, often, the pathogenesis and pathology of these diseases are completely missed and one is likely to think that it is purely an organic disease. Coronary insufficiency, thyrotoxicosis, bronchial asthma or peptic ulcers are some of the glaring examples of such a state of affair. Unless we realize the earlier

background of these patients and unless we try to overcome them in the early stage, we can never be able to provide them a complete and lasting recovery.

Further, when these organic lesions are seen in a given organ, one can also witness plasma cells and lymphocytic infiltration along with excess of liberation of histamine and histaminase in the blood. In appears that it is this histamine which ultimately initiates the healing process by causing vaso-dilatation leading to fibrosis. The symptom complex of these fully developed stress disorders is too well known to be repeated here. The pathological features remain in these organs for a considerable period of time and ultimately the person may succumb to one of the complications of these diseases during the course of time. However, if he survives, he may get complete healing and fibrosis. But then he becomes a victim of hypoactivity of these organs leading to diabetes mellitus, myxoedema, emphysema, cardiac infarction etc.

CHAPTER 9

Principles of Therapy of Stress Disorders

Now, it can be well realized that the therapy for stress disorders can be planned depending mainly on the stage at which the patient has sought medical advice (Table 1).

Thus, in the first phase, mainly with psychic features, the principle of treatment would be the efficient delivery of psychotherapy. According to modern trends, such a psychotherapy should ordinarily be given by psychiatrists. However, since the incidence of psychosomatic disease is high and is increasing daily ,it is very essential that every medical man is fully conversant with the principles of psychotherapy. Unconsciously or consciously every doctor does give some type of psychotherapy to all his patients.In fact success or failure in the practice of community medicine mainly depends upon how much one deals with the psychological aspects of medicine to give a complete cure to his patient.

In fact, attentive listening to the patients' complaints in great detail would itself help the patients to unburden their emotional disturbances and ease the mental tension and cause relief to them. Similarly, unburdening of one's mental tension to one's close relatives or friends everyday seems to be the best first aid to remove mental stress and strain. Hence, patients with acute mental stress should be encouraged to talk of their mental problems regularly to someone who can analyse their problems and give helpful suggestions.

In addition, in developing countries like India, various other measures are also taken which have a direct bearing on the mind. These include worshipping God either at one's own residence or in a temple. By doing so, many mental problems are eased. Similarly, by regular chanting of Mantras, reading

holy "Quran" or "Bible" loudly, may also produce some mental satisfaction or relief. It appears that many of the traditional practices and ceremonies which are directly or indirectly related to the offerings to God or worshipping God, are nothing but a sort of psychotherapy. If in spite of all these prayers and offerings one happens to face adversities in life, he meets them boldy and with confidence thinking that they are unavoidable and he is destined to overcome all the difficulties. Because of his specific make-up and attitude toward life during the period of adverse circumstances and situations he does not get the real impact of stress and strain of life and he faces them with much tolerance and composure, since he feels that his misfortunes are the result of his own misdeeds of his previous births and he cannot possibly escape them.

Table 1.

PHASE	*PSYCHIC PHASE*	*PSYCHOSOMATIC PHASE*
CLINICAL FEATURES	NERVOUSNESS IRRITABILITY SLEEPLESSNESS	PALPITATION HIGH B. P. RAPID PULSE
TREATMENT	PSYCHOTHERAPY YOGIC PRACTICE	PSYCHOTHERAPY YOGA PSY. DRUGS
SOMATIC PHASE	ORGANIC PHASE	
SYMPTOMS OF HYPERFUNCTIO-NING ORGANS	SYMPTOMS OF PATHOLOGICALLY DETECTABLE LESIONS	
YOGA PSY. DRUGS SPEC. MEDICINE	SPEC. MEDICINE AND/OR SURGERY	

Because of the faith in God and religious attitude even now in all the developing nations the incidence of most of the stress disorders is comparatively low, especially in the rural areas. Thus, it is said that heart attacks are unknown in the African Zulu and rare in many of the Asian countries. All these psychotherapeutic measures have not only a great preventive value, but also have a great bearing on curative medicine. However, in the so called civilized communities and well developed nations there is not much scope for such type of psychotherapy. Hence, it becomes apparent that the more civilized one becomes the greater are the chances of his developing some type of stress disorder sooner of later. Therefore, the only way to protect oneself from the ravages of these stress disorders is to go back to our well documented ancient customs and systems, reform them to suit the modern society and follow them meticulously in order to avoid the development of stress disorders in the later part of life. Unless some such stringent measures are taken, these stress disorders may obtain the position of epidemic diseases which engulfed the world in the middle of 19th century and killed the people during their very active and productive period of life.

Role of Tranquillizers

One of the most outstanding contributions in the field of psychosomatic medicine in recent years is the discovery of tranquillizers. At first it was the discovery of reserpine from the herb Rauwolfia serpentina that initiated the interest. It was found that the use of this drug not only reduced blood pressure, but also produced a sedative action mostly by reducing the neurohumoral content of the hypothalamus. However, it had many side effects, and hence many synthetic preparations were studied which could simulate the sedative effects without the side effects. Amongst them maprabromates and diazepam were found to be very useful in stressful situations. Amongst the two groups diazepam seems to be having a very specific action on the limbic system and hypothalamus by which it selectively reduces the neurohumoral content of Diencephalon

through its sedative and tranquillizing action. Because of this it is found to be an ideal preparation for overcoming all the stress phenomena especially during acute stage. However, one of the drawbacks of this drug is that it may lose its beneficial effect when it is used for a long time and hence it may also cause drug addiction.

In order to avoid this complication one will have to adopt some alternative meaures such as relaxation exercises to be discussed later on to give a lasting relief.

Many times it is very gratifying to observe beneficial effects of these drugs on patients with paychosomatic phenomenon. In fact , after the use of these drugs for some period, one can observe a significant improvement in the emotional and behavioural pattern of these patients. They sleep well and their irritability and palpitation become much reduced. Their blood pressure tends to come down gradually till it touches the basal level within a short period provided there are no other organic changes in the walls of the blood vessels. However, if the stress phenomenon is more severe, then one will have to use major tranquillizers, such as chlorpromazine to tide over the acute phase of the disease. Along with these specific drug therapies one should use appropriate psychotherapy and also relaxation therapy to control the stressful situation permanently.

Yoga and Relaxation Therapy

Yoga has been practised in India for a number of centuries. However, its utility in controlling various stress diseases has been explored only recently·especially in the West in USA and UK. There are several methods of yogic practice originating from different schools of thought. Amongst them, the one propounded by Patanjali seems to be the most popular and the universally accepted one. Though he had described eight stages, in short they could be grouped into three, namely (a) Postural exercises (b) Breathing exercises and (c) Meditation. In addition, one is expected to observe some restraint and moderation in all his bodily and behavioural activities during

the practice of Yoga. The postural exercises described in Yoga are isometric exercises and hence the results of these exercises are quite different from the physical exercises performed as per standard Western methods. The beneficial effects of all these exercises have already been described in detail elsewhere. Suffice it to say here that a regular practice of these yogic exercises improves the psychological functions of the individual. This is followed by improvement of memory and even of intelligence quotient. Psysiologically, the pulse rate, respiratory rate and blood pressure decrease after Yogic practice. Biochemically, there occurs a decrease in the circulating acetylcholine levels, and slight to moderate increase of catecholamine and cortisol. Serum cholesterol and blood sugar levels are decreased along with an increase in serum proteins. Further, the serum PBI is also increased which indicates improved thyroid function . All these findings suggest that there occurs an overall improvement in the bodily functions possibly due to improvement in the microcirculation leading to more efficient oxygen supply to all the organs and tissues of the body. Because of this, the aging process becomes somewhat delayed and stress competence is improved if it is practised regularly everyday. Further, it was also noted that these effects are short-lived and have no cumulative effect.

The deep breathing exercise also produced almost similar results as we obtained after postural exercises. The technique has already been described elsewhere and one should usually do it 10 to 20 times per day depending upon one's own capacity. This produces the desired results by improving the microcirculation especially of most of the vital centres such as cardio-respiratory, cerebral etc.

Meditation is practised in different manners by different people. There are no universally accepted techniques. Buddhists adopt Vipassana type of meditation which consists of concentraing on one's own breath after sitting in a comfortable position in a secluded place and shutting off the sense organs as best as one can. In the transcendental meditation described by Mahesh Yogi chanting of some Mantras or sacred words

while sitting in a relaxed position for 15 to 20 minutes is also prescribed. Whatever may be the technique, one has to sit in a comfortable position and close his eyes and other sense organs as best as he can and then give a complete freedom to the mind to empty all the stress and strain of the day. If this is practised daily, it causes efficient relaxation of the mind and gives a freshness to the entire psychosomatic apparatus to restart its work with greater vigor and strength.

When we studied this phenomenon in human volunteers after Vipassana meditation, we observed enhancement in the blood levels of neurohumors along with a reduction in plasma cortisol levels. This possibly indicates a decrease in the psychosomatic stress and improvement in the capacity to do more of intellectual work.

When one practises all these three methods, namely postural exercises, breathing exercise and meditation daily one after another, remarkable results could be obtained to maintain a good physical and mental health.

CLINICAL STUDIES

Enconraged by this experience on healthy volunteers, we also prescribed these yogic practices to patients with diffe :ent types of stress disorders with due regard to their stage of psychic disturbance present at the time of starting Yogic practice. Most of them felt much subjective improvement. However, this needs further study and investigation. Usually in such cases we started both tranquillizers and Yogic practices in the initial period. When improvement in the psychic symptoms was seen the tranquillizers were gradually reduced and the patients were then prescribed only the Yogic exercises. By this combined therapy so far we have treated 1007 cases of psychosomatic disorders with marked and sustained improvements in about 75 per cent of the cases of the first, second and third stage within a period of 3 to 6 months. In the remaining cases the objective improvements were not quite visible, but further deterioration of their condition could be prevented by regular practice of Yoga.

RELAXATION RESPONSES

There are many other relaxation responses practised extensively in different parts of the world with equally good results, such as the one popularized by Benson. The Biofeedback method which was extensively studied by Miller in experimental animals, is now being subjected to elaborate clinical trials. It appears that in properly selected cases and with the necessary facilities it can be a good substitute for Yogic practice, especially for meditation. However, this does not replace the postural exercises or breathing exercises described in Yoga for improving microcirculation in various organs and tissues.

Similarly, autogenic training practices in Germany or Zen meditation popularized in Japan also yield equally good results. In the absence of any comparative data it would be safe to presume that all these measures probably give equally good results, though a combined practice of Yoga may be preferable to all, in view of its additional advantage of improving microcirculation to all the vital organs in the body.

SPECIFIC MEDICAL MEASURES

When a stress disease involves a particular organ fully after the repeated neurohumoral and microvascular changes, then various typical manifestations of the involvement of that organ such as coronary insufficiency, chronic peptic ulcer etc. become quite obvious. As the pathophysiology of the disease progresses, the psychic manifestations gradually become less and less and the signs and symptoms of organic pathology become fully established and manifested. The features of various pathological changes become apparent such as the development of autoimmune phenomenon leading to chronic inflammatory changes including ulceration in the mucosa which is followed by healing and fibrosis. In blood vessels such changes lead to calcification of the vessel wall. All these organic changes cannot be reversed completely towards normalcy by any medical measure and hence the residual changes would remain permanently in the respective organs and tissues. Thus, in order to hasten the healing process early and control

these stress disorders specific medical measures should be adopted. Accordingly, in thyrotoxicosis the antithyroid measures such as Neomercazole should be taken till the chronic inflammatory reaction subsides. Similarly, in asthma and ulcerative colitis one should give small doses of cortisone to suppress inflammation. For peptic ulcer, antacids and anticholinergic agents are needed to overcome the disease. For controlling the blood vessels pathology, sympatholytics, beta blockers and anticholesteremic agents would be necessary. Like this, in all cases of stress disorders of individual organs one should use anti-inflammatory agents along with specific drugs to give a lasting relief. But in addition, tranquillizers and Yogic practice might also be required in many of them to control the main cause of the development of these diseases and also to prevent further deterioration of their condition.

SURGICAL TREATMENT

In advanced cases with fully established pathological lesions such as the long-standing cases of thyrotoxicosis, peptic ulcer or ulcerative colitis, mere medical measures may not give complete relief. Hence, in such cases, appropriate surgical treatment in the form of subtotal thyroidectomy, partial gastrectomy or colectomy respectively will have to be instituted to get over the main pathological lesion. Here also, even after the appropriate surgical measures the psychotherapeutic measures already discussed may be required to cure the disorders fully, failing which recurrence is bound to occur in most cases.

Summary

Whenever a person is exposed to psychosomatic stress beyond his tolerance, a series of mental and bodily changes take place in succession. The changes can be divided into four stages.

At the first or psychic stage there occur only mental changes leading to alteration in the behaviour such as sleeplessness, irritability, nervousness, restlessness etc. These functional changes are usually accompanied by increased

acetylcholine turnover in the cerebral cortex which occurs as a result of overactivity of the entire central nervous system.

At the second stage, as the stressful situation continues, more and more of the neuroendocrine apparatus and the centres of autonomic nervous system in the hypothalamus, especially those of sympathetic nervous system become stimulated. As a result, many of the bodily changes leading to increased activity of the sympathetic nervous system become obvious in addition to the earlier mentioned hyperfunctioning symptoms of central nervous system. Thus, during this stage, there may be evidence of increased blood pressure, tachycardia, increased thyroid function etc. In the third stage or somatic phase, gradually the stress disorder settles down in one of the organs as a result of excessive action of autonomic nervous system. In some organs it is the excessive action of sympathetic nerves, such as heart and blood vessels, whereas in others it is the excessive action of parasympathetic nerves such as in chronic peptic ulcer, bronchial asthma etc. The exact cause of the involvement of a particular organ is to be found in the genetical and environmental background of each individual. This varies from person to person and hence, it is ordinarily difficult to predict in each case as to which organ will be the target of stress disease. One has to look out for the hyperfunctioning of one or more organs, such as hyperchlorhydria, hyperthyroid state, angina pectoris etc. However, since there are hardly any visible organic changes at this stage, they are reversible. In the fourth stage or organic phase there are pathologically and radiologically demonstrable changes in the organs, possibly because of prolonged action of neurohumors. These lesions need either specific medical or surgical treatment to overcome the disease. The full knowledge of all these possibilities is essential for a thorough understanding of the problem, so that a proper diagnosis of the stress disorder and also its stage could be correctly assessed and managed. Apart from taking a detailed history of the psychological and bodily complaints one should also carry out certain laboratory investigations such as acetylcholine, catecholamine, histamine and plasma cortisol either in blood or urine to biochemically assess

the exact stage and severity of the stress disorder. If the signs and symptoms refer to any specific organ, the extent of the functional and organic lesions should be assessed by following various biochemical and radiological studies. From all these investigative procedures one should be able to correctly label each case whether it is purely psychological or it is a case of psychosomatic disease or whether it has now become a fully established bodily or organic disorder.

Treatment should be planned as per the stage of the disease. If the disease is purely in the psychic phase with various psychological manifestations, then psychotherapy in different forms along with appropriate tranquillizers would be the ideal treatment. One will have to individualize the psychotherapy in each case depending upon his or her psychic background. The tranquillizers could be minor or major, depending upon the severity of the case. In addition, effective reassurance and change of environment would also help the patient. In the second or psychosomatic stage of the disease apart from the psychotherapy and tranquillizers, one whould treat the involved hyperfunctioning autonomic nervous system by giving anticholinergic drugs in case of parasympathetic hyperactivity and alpha or beta adrenergic blockers in case of sympathetic hyperactivity. In order to reduce the hyperactivity of endocrines, especially the adrenal cortex, one may have to give anabolic hormones and insulin in small dosage to counteract the metabolic disturbances. In the third stage, in which the target organ become affected and hyperactive, appropriate medical measures should be given to get prompt relief. Amongst non-medical measures, Yogic exercises give the maximum help to reduce the overactivity of the central and autonomic nervous system during all the periods of stressful state. By doing so one can reduce the requirement of tranquillizers to a bare minimum.

At the fourth stage of the disease, the patients come with fully established organic lesions and typical clinical, radiological and laboratory findings. In this stage, the diagnosis of the stress disorder becomes comparatively easier. Here, keeping in view the severity of the case one should adopt either medical or

surgical measures. However, the results of the treatment would be lasting and permanent only if the various earlier mentioned psychic and psychosomatic measures are also adopted before and after the specific medical and surgical treatment.

In short, these stress disorders affect the entire psychosomatic apparatus of an individual and hence, only removal or treatment of the lesion from one of the specifically affected organs will not give complete relief, unless the disturbance of the entire psychosomatic constitution is taken into consideration and treated as such. It would be utterly futile to treat one or two of the obviously involved organs, since, recurrences are bound to occur in the same organ or in some other organ, unless the treatment is instituted to cure the illness of the whole psychosomatic constitution.

CHAPTER 10

Role of Yoga in Stress

Mankind has always tried to attain peace and happiness through all available means. The urgency of getting an ideal method of attaining mental peace has become great in view of the tremendous increase in the stress and strain of life especially in urban areas. The rapid industrialization and urbanization leading to excessive crowding, too much of competition, excessive hurry and worry are some of the important factors which ultimately lead to mental and physical changes. Initially, a man tries to adapt himself to face such a strain. However, if such a situation is allowed to continue for a long time the person fails to adapt himself and then he starts getting the manifestations of psychosomatic changes one by one. At first he gets psychic changes such as irritability, nervousness, sleeplessness etc. If the process is not recognized and checked in time he gets some additional manifestations such as palpitation, increased pulse rate, rise of blood pressure etc. As these changes continue, he ultimately becomes a victim of one of the psychosomatic stress disorders such as hypertension, ischaemic heart disease, peptic ulcer, diabetes mellitus, ulcerative colitis, bronchial asthma, thyrotoxicosis, migraine, rheumatoid arthritis etc. Why a particular person falls a victim to any one of these stress diseases, depends upon his genetic factors, psychosomatic constitution and the various environmental factors, such as nutritional status, habit, climate, nature of work etc.

Amongst all these diseases hypertension with or without ischaemic heart disease and/or diabetes mellitus seems to be the most common disease. It is a world-wide phenomenon and the more advanced the country, the greater is the incidence of

these diseases. Thus, in UK one in every 10 persons in the age group of 30 to 50 years is a victim of this disease, whereas in USA cardiovascular stress disorder seems to be the most important cause of death during the past few years. What is most alarming is that the incidence is still increasing and is affecting more and more of younger generation.

It is gratifying to note that more and more powerful drugs are being produced and marketed for the benefit of such patients. However, the use of such powerful drugs has its own drawbacks, such as drug dependency, drug addiction, and toxic manifestation if used for a long time.

Hence, in recent years there has been an intense search for non-medical measures not only to have control over these diseases, but also to prevent the development of these disorders. Man would like to mould his psychosomatic apparatus in such a way that he can boldy face the stress and strain of modern life without much difficulty. In fact, the problem of modern man is to learn how to increase his stress threshold or stress competence.

If we look into the ancient past of mankind, we can easily find out some of the methods described by the earlier philosophers, sages and spiritual leaders for maintaining tranquillity of mind. Amongst them Yoga seems to be the earliest and the most effective method for providing peace and tranquillity of mind. However, there are several other methods which have developed in various parts of the world and all these have probably derived their ins rations from Yoga in the early periods.

Thus, in the Far East, especially in Japan, Zen meditation seems to be a well developed method for attaining mental peace. The word *'Zen'* is derived from Chinese word *"Chan"*, which in turn has been derived from the Sanskrit word *"Dhyana"*. From this, it becomes clear that along with Buddhism the principles of Zen, which is nothing but a method of enlightenment, travelled at first to China and then to Japan some time in the 12th century C.E. Since then, the system of Zen meditation has developed well. This Zen meditation is practised in most of the Buddhist temples in Japan. The main

credit goes to Suzuki who explained scientific details of Zen meditation to the rest of the world in his voluminous work.

Sufism

In the Middle East where Islamic culture has been flourishing during the last 12 centuries, the control of mental activity was done through the *Sufi* way. It appears that even the Sufi way might have gone from India, just as Zen meditation went to Far East. The main Sufi technique includes prayer which is nothing but another form of *'Bhakti Yoga'*. By this and other similar practices people belonging to Islamic culture and civilization attain mental peace.

Recently, in Europe and especially in Germany, "autogenic training" as developed by Schultz and his colleagues became a popular method of achieving mental relaxation. In this, various types of auto-suggestion and regular practice of relaxation lead to relief from many of the psychosomatic conditions. Jacobson in USA developed a technique of producing effective muscular relaxation, since he felt that this would ultimately lead to relaxation of mind also. However, in this technique there is no definite way of assessing how much a person has really gained out of his practice. Hence, in recent years they have developed suitable equipment to measure exactly how much relaxation one could attain after the practice each time. This new technique is called "Biofeedback," in which the auto-suggestion of Schultz and the relaxation technique of Jacobson are combined and one can now accurately assess the progress towards the end of each relaxation session.

In spite of the availability of all these methods in various parts of the world, one must realize that the basic principles involved in the development of these techniques are those of Yoga. Each one of these techniques has highlighted only one or the other aspect of Yoga either for the relxation of the body or of the mind. Therefore, these techniques are not complee. If one wants to derive full benefit of Yoga, he must follow in principle the full eightfold Yogic discipline described by Patanjali about 2000 years ago. Since, all these techniques had a root

in Yoga, which originated in India, it is high time that we should not only study, but also conduct research into the various aspects of Yoga so that the humanity at large, which is so keen to know more about Yoga, can derive fullest benefit from it and get over the stress and strain of modern life without much difficulty.

The practice of Yoga has come down from the pre-historical past. The references to Yoga are available in Upanishads and Puranas composd by Indian Aryans in the later Vedic and post-Vedic period. It seems, there developed many schools of Yoga, advocating different methods. Therefore, the main credit for systematizing Yoga goes to Patanjali, who is the author of *Yoga Sutra*. Though, he composed the treatise in brief code words known as "Sutras", it is the most important basic text on Yoga on which a large number of commentaries were written by scholars not only of this country, but also by scholars from all over the world. It is through this basic treatise that the essential message of Yoga spread throughout the world. Amongst the people, who popularize the Yoga system throughout the world, the name of Swami Vivekananda stands out most prominently. By giving a scientific interpretation of Yogic methods and by supplementing them with the philosophical thoughts as described in *Bhagavad Gita*, he made the greatest contribution to the physical and mental harmony throughout the world, especially in the countries of the West like USA, UK etc. In recent years Sri Aurobindo also made many original contributions in this field, especially in the field of mind and consciousness.

From the common man's angle, one of the earliest and most important contributions was made by Buddha, about 2500 years ago, which was easy to comprehend and practice. Because of this only his message for universal harmony was quickly taken over by the people all over the world, especially by the people of Asian countries.

Thus, from the time of *Bhagavad Gita* which is a part of *Mahabharata* onwards the literature on the science and philosophy of Yoga has been increasingly enriched throughout the

world bypioneering scholars in the field by writing and preaching their experience of Yoga and related subjects.

Methods

Though, the overall aim of Yoga remains the same, namely the attainment of the physical, mental and spiritual health, the methods described to achieve this goal are manifold. Those people who advocate only *Hatha Yoga* or the practice of physical postures feel that this is the most fundamental part of yoga and hence it must be practice by everyone. After mastering the techniques of physical postures only one should try to do the other more complicated exercises such as *Pranayama* or breathing control and *Dhyana* or meditation. On the other hand, many other exponents feel that in order to attain the higher level of mental activity quickly one can straight away start the practice of meditation. They feel that if one can learn to control the unstable mind all the bodily systems automatically become adjusted. Avoiding all this confusion, Patanjali has recommended eight stages of Yoga discipline. They are *Yama* (Restraints), 2. *Niyama* (observances), 3. *Asana* (Physical postures), 4. *Pranayama* (Breathing control), 5. *Pratyahara* (Withdrawal of sense organs), 6. *Dharana* (Contemplation), 7. *Dhyana* (Meditation) and 8. *Samadhi* (attainment of superconsciousness).

Though, Patanjali has described all these stages in great detail, in some modification is necessary to suit the modern society. Thus, a combined practice of physical postures, breathing exercises and meditation in a sequence is the best compromise to meet the present day need of the society. The results of these practices can be enhanced much more if one follows all the recommended restraints and observances in everyday life. It may not always be possible to follow them very strictly in everyday life, but one should try one's best to get better results.

Yamas or restraints are five, viz. 1. *Ahimsa* or non-violence including avoiding bodily or mental injury; 2. *Satya* or truthfulness in all the dealings of life; 3. *Asteya* or non-stealing of anything in life such as money, material, ideas, speeches or

writings; 4. *Brahmacharya* or celibacy, which means refraining from all the activities related to sexual enjoyment directly or indirectly; 5. *Aparigraha* or non-possession ie. keeping one's requirements to the bare minimum. All these five restraints are meant to prevent a person from indulging in too many undesirable worldly activities injurious to his physical and mental health.

Similarly, Patanjali has prescribed five *Niyamas* or observances in life. They are: (1) *Shaucha* or cleanliness of body and mind: One should acquire clean habits in every walks of life; one should also keep his mind clean by avoiding passion, anger, greed, delusion, pride and jealousy which may lead to the development of abnormal behaviour. (2) *Santosha* or contentment: One should always develop a habit of contentment even under adverse circumstances so that he can concentrate and meditate without any obstacle to achieve his goal. (3) *Tapas* or austerity with regard to food, exercise, rest and recreation which will ultimately lead to the development of integrity in one's character. (4) *Svadhyaya* or intensive study: In order to make life healthy, happy and peaceful it is essential that we make an extensive study of the subjects in which we want to specialize. (5) *Ishvara Pranidhana*: In order to attain peace and a sense of humility it is always better to dedicate the actions and the fruits of our actions to God Almighty. This will help us to cultivate superior qualities of cultured human beings such as love, kindness, affection, charity etc. Unless we develop such an attitude of dedication in life we will not be able to concentrate and meditate. *Yama* and *Niyama* are to be fully understood and followed as far as possible by everyone interested in the practice of Yoga.

As regards physical postures (*Asana*), *Pranayama* (Breathing Exercise) and Meditation, it would be much better and safer if one learns them from trained Yoga teachers directly rather than from published articles or books. All these should be practiced very carefully and regularly, failing which, they may do more harm than good. Therefore, first one should learn the correct techniques from the preceptor and then perform them regularly in the morning on empty stomach. If one does

not get time in the morning, he can conveniently practice them in the evening, but in that case, one should regularly follow the same routine. Usually one starts with selected physical postures for a period of 15 minutes, followed by breathing exercises for 5 minutes, and then meditation for 10 minutes everyday. If one starts doing these practices with firm determination from the very beginning, then it becomes a regular habit and an integral part of the daily routine. The beneficial results of these practices, to be discussed later, can be perceived by each prectitioner within a few days and then they continue to increase as one goes on practicing them everyday.

When one practices Yogic discipline for some time one gradually gets a feeling that he has developed an enhanced capacity to do more of creative work. In case, one does not fully utilize the creative energy released by these Yogic practices, there is a possibility that he may misuse such creative energy for his own ultimate destruction. Because of this, one has to channelize his activated energy in such a way that it ultimately benefits the humanity at large.

Since, there are different people with different physical and mental constitutions, there should be different methods to be adopted by them for serving the humanity at large. Though, there are many kinds of Yoga, three of them are more important—(1) *Karma Yoga* or Yoga of Action, (2) *Bhakti Yoga* or Yoga of Love and Devotion and (3) *Jnana Yoga* or Yoga of Knowledge.

Karma Yoga means performing one's duties in the form of service to the people sincerely and to the best of abilities without expecting anything in return. In *Bhakti Yoga* one carries on his duties with great humility and devotion and tries to surrender himself completely to God Almighty. Whatever the good thing that happens as a result of his activity, he gives credit to God rather than to himself. Such a philosophy in life would usually lead to great success. In *Jnana Yoga* one attains great height by means of his intellectual activity. In short, any of these three principal pathways may be followed to achieve the goal of one's life, and without expecting anything in return which would benefit him personally. In this connection the

Bhagavad Gita is the most authoritative text which gives in detail, the philosphical and practical aspects of these Yogic practices which have received universal approbation throughout the world.

Results

It is now well known, that all those who strictly follow the principles and practices of Yoga, attain great things in their life time for the benefit of humanity at large. The ancient texts, *Upanishads* and *Puranas* bear this out. These texts have proved enormously beneficial to the mankind by inspiring universal harmony. It would not be an exaggeration to say that in recent times these ancient writings produced greater impact on the people of Western countries than our own. For example, the great German author Max Muller studied and translated the *Vedas* and *Upanishads* into Western languages and spread the messages of these immortal books for activizing the feeling of universal brotherhood and peace. Amongst them *Bhagavad Gita*, which is one of the most important texts on Yoga, made greatest impact on the world in spreading the message of universal harmony, love and affection.

Another important historical fact, which also enabled us to spread the messages of universal harmony in the world, especially in Asian countries, is the birth of Buddha. He renounced his kingdom and practiced meditation for years, before he could attain enlightenment about the cause of human sufferings and also the methods to alleviate them. According to him, the main cause of human suffering is ignorance which leads to desire. All these physical and mental sufferings can be removed by practicing self-discipline which is a part of the Yoga preached by Buddha. Because of its simplicity and mass appeal his message quickly went outside India and spread throughout the world especially in the South and South East Asian countries.

In the recent past, one of the persons who made maximum contributions for spreading the message of universal harmony through Yoga, was Swami Vivekananda. The main theme of his lectures delivered throughout the world, especially in USA

and UK was based on the *Bhagavad Gita* and Patanjali's *Yoga Sutra*. In his address at Pasadena in California, USA in 1900 on "the Ideal of a Universal Religion" he stated: "World is exercised in the later part of this century by the question of harmony in society. Various plans are being proposed and attempts are made to carry them into practice but we know how difficult it is to do so. People find that it is almost impossible to mitigate the fury of the struggle of life, to tone down the tremendous nervous tension that is in man. Now, if it is so difficult to bring harmony and peace to the physical plane of life, the external, gross and outward side of it, then it is thousand times more difficult to bring peace and harmony to rule over the internal nature of man."

After discussing the main problems which the human society faces these days, he suggested ways and means for overcoming them. Thus he says: "To become harmoniously balanced in all directions, is my ideal of religion. And this religion is attained by what we in India call Yoga or Union. To the worker it is the union between men and the whole of humanity... from the lowest man to the highest Yogi all have to use the same method and that method is what is called concentration... The more this power of concentration, the more knowledge is acquired because this is the one and only method of acquiring knowledge." After acquiring knowledge through concentration one tries to perform all his activities by following any one method of Yoga that suits his status and capacity. It may be *Karma Yoga, Bhakti Yoga* or *Jnana Yoga*. But one must practice any one of them regularly and seriously. Thus Vivekanand concludes: "Lastly, it is imperative that all these various Yogas should be carried out in practice. Mere theories about them will not do any good. First, we have to hear about them, then we have to think about them. We have to reason the thoughts, impress them on our minds and we have to meditate on them, realize them until at last they become our whole life." Swami Vivekananda spread the message of Yoga of various types throughout the world. Many notable persons practiced and followed these techniques and achieved great things in their lifetime. Thus, amongst the Karma Yogis, the Father of

our nation Mahatma Gandhi is the ideal person to be emulated. He was an ardent follower of the *Bhagavad Gita* and he used to recite a number of verses from the *Gita* daily during his evening prayer. He preached universal love and non-violence and it is these basic principles of life which made him great and Mahatma, Later, Pandit Nehru supported and practiced various types of Yoga. Possibly, it is the practice of these Yogas from their very childhood which enabled them to face the enormous stress and strain of life with such great courage and strength. We can give many more examples of those who could achieve great things in life by the practice of Yoga. But suffice it to say here that it is a powerful means for maintaining good physical and mental health throughout the life if it is regularly practiced from an early age.

Yoga and Stress Disorders

As already stated, too much of stress and strain of life especially after the middle age, may lead to one of the stress diseases. As the developing countries are also becoming more and more industrialized, the number of these diseases are increasing at a very fast rate. Hence, there is an urgent need for taking proper measures to prevent the development of such diseases and also to recognize and treat them in the early stages. Though recently innumerable tranquillizing agents have been discovered and marketed, all of them have certain toxic and habit forming properties. Hence, their use should be limited to the bare minimum followed by certain non-medical measures such as different types of Yogic practice to control these diseases. These Yogic practices not only help in reversing the progress of these diseases but also improve the resistance of the body at the psycho-physiological level. Such non-medical measures should be adopted to overcome the stressful situations and to maintain an alert mental state. This would largely avoid severe mental depression resulting from too much use of tranquillizers. Because of these dangers, there is an urgent need for popularizing the use of various types of Yogic practices throughout the world. There are already many organizations such as Transcendental Meditation Centres of Maharshi

Mahesh Yogi in USA, UK and Switzerland and many other similar centres which are doing a useful service to the humanity at large.

So far, we have treated 1007 cases of various stress disorders with very encouraging results. The patients of high blood pressure, diabetes and asthma, who came to us at an early stage, showed very good improvement. Those who came later, their drug requirement was considerably reduced after starting the Yogic practice. We are still following all these cases and we would be able to evaluate them in the near future.

It is a known fact that the standard of living of the people all over the world is improving considerably, thanks to the enormous countributions made by science and technology in recent years. In some countries it is improving at a fast rate whereas in others the pace of growth is slow. In some areas of the world the growth has reached a saturation point whereas in others people are still struggling to attain their honoured position as quickly as possible. It is known that when there occurs an improvement in the material wealth of people, stress and strain of the mind also increase. That is why in these countries the incidence of stress disorders is also increasing at a very fast rate. Therefore, in order to lead a happy and prosperous life in a well developed country with utmost harmony in society Yoga can play an important role throughout the world. In fact, Yoga is defined as science of mental control. It not only helps one to control one's mental state, but also to improve one's personality and behaviour, if it is practised regularly from childhood. In middle and old age groups if appropriate Yogic practices are continued it may delay the aging and degenerating process, with the result that a person may remain active and energetic for a considerably longer period of life.

Thus, for maintaining a good physical and mental health, one should adopt all the three types of Yogic practices, namely *Asanas, Pranayama* and Meditation. All these should be continued daily in the morning or evening for about half an hour or so.

Once one masters the techniques of these Yogic practices and starts experiencing the changes in one's bodily and mental

health, one will adopt any one of the pathways to achieve the goal of his life. Yoga is a means or vehicle through which man can easily climb up the ladder of his progress. In fact, the enormous latent energy that would be let out after all these Yogic practices should be properly channelized through *Karma Yoga, Bhakti Yoga* or *Jnana Yoga* so as to enable one to serve humanity in the best possible manner. There is no doubt that it would ultimately lead to universal harmony.

One of the most outstanding examples of such an achievement is Mahatma Gandhi himself. By closely following the methods of *Karma Yoga* he made the greatest contribution to the humanity at large. He served the people of India especially the under-privileged people in a most humble and sincere manner without expecting anything in return. That is why his monumental social work is recognized and remembered throughout the world. Subsequently, his technique was adopted by many social reformers throughout the world with equally impressive results. Thus, he is a real example of how Yoga can produce universal harmony.

Amongst the persons who carried the messages of Yoga to the rest of the world, we must remember the name of Swami Vivekananda. Although a large number of people are doing similar work all over the world, his notable contributions are most outstanding. He was not only a preacher of Yoga, but also a regular practitioner. His contributions in this field are enormous and have left a permanent impression on the people throughout the world. It is indeed a matter of great satisfaction that the pioneering work started by Swami Vivekananda is being carried on by a large number of workers in various parts of the world. Maharshi Mahesh Yogi, Swami Rama, Swami Chinmoyananda, Swami Ranganathananda, are well known persons, who by their enormous contributions to Yoga are well recognized and respected throughout the world. It is they and other similar persons who are the real ambassadors of peace. I am sure, if everyone of us rises to the occasion and makes some such contribution to the betterment of humanity, it would lead to peace and harmony in which all people would live happily and lead a very active and prosperous life.

CHAPTER 11

Studies on Physiological Aspects of Yoga

It has been stated that daily practice of Yoga would help a person to maintain a perfect homeostasis of the body and mind throughout his life. In fact, the practice of Hatha Yoga and Meditation tends to bring about normalcy in our psychophysiological functions. It has been claimed that such persons would be less prone to psychosomatic imbalance resulting usually from stress and strain of life. In order to test the above claims, one will have to conduct modern scientific studies on human beings by using all the presently available physiological and biochemical methods.

Such scientific studies can be conducted in two ways: (1) By carrying on intensive studies of the well established and reputed Yogis, and (2) By undertaking studies of normal volunteers who are prepared to undergo the required number and type of Yogic exercises everyday. The studies conducted by both these methods have much utility. However, from the common man's point of view the second method, namely that of normal volunteers, has greater application in view of its preventive and curative value. In fact, a common man would like to know what benefit he is likely to get from Yogic practice if he starts the same from now onwards. He is perhaps less likely to take much interest in knowing what miracles a particular Yogi can perform and with what dexterity. In veiw of the above, we conducted our studies on normal volunteers who were made to undertake various types of Yogic practices as required by us. Those who want to know more about the performance of expert Yogis, are referred to some of the poineering studies of Anand and Chhina, Kothari, Green, Wallace and others.

INDIVIDUAL *ASANAS*

Scientifically, it would be essential to know the effects of each Yogic posture on normal human volunteers. Hence, we studied the effects of three common individual *Asanas* on normal healthy volunteers of 20 to 25 years age. They were (*a*) *Shirshasana* or head stand posture, (*b*) *Sarvangasana* or posture of all the limbs and organs and (*c*) *Shavasana* or posture of relaxation. In each case 8 volunteers practiced one of these three *Asanas* everyday for a period of three months. Their pulse, respiration, blood pressure, body weight and breath holding times were recorded in the begining and after the termination of the period. Simultaneously, their 24 hour urinary excretion of choline, adrenaline, noradrenaline and 17-Hydroxycorticosteroids were also estimated before undertaking and at the end of these individual Yogic practices. These hormones which indicate the severity of stress, are very sensitive parameters of assessing stress reactions.

GROUP OF 4 *ASANAS*

In this group, 4 *Asanas* as given in the table, were practised by volunteers for a period of six months. The parameters for assessing the value of these Yogic practices remained the same as mentioned in the individual posture studies.

GROUP OF 12 *ASANAS*

The details of 12 *Asanas* and the method of study of these *Asanas* have already been dealt by us earlier. Suffice it to say here that the study of vounteers after these Yogic practices revealed a wealth of informations about the effect of Yogic practice on normal healthy individuals (Figs. 27,28,29).

THE PRACTICE OF *PRANAYAMA* OR BREATH CONTROL

Normally, the practice of various postural exercises is followed by the *Pranayama* or breath control exercise (Fig. 30). In order to assess its value, we studied the effect of breath control exercise on a group of volunteers. This exercise was done by some volunteers in a particualr sequence viz. inspira-

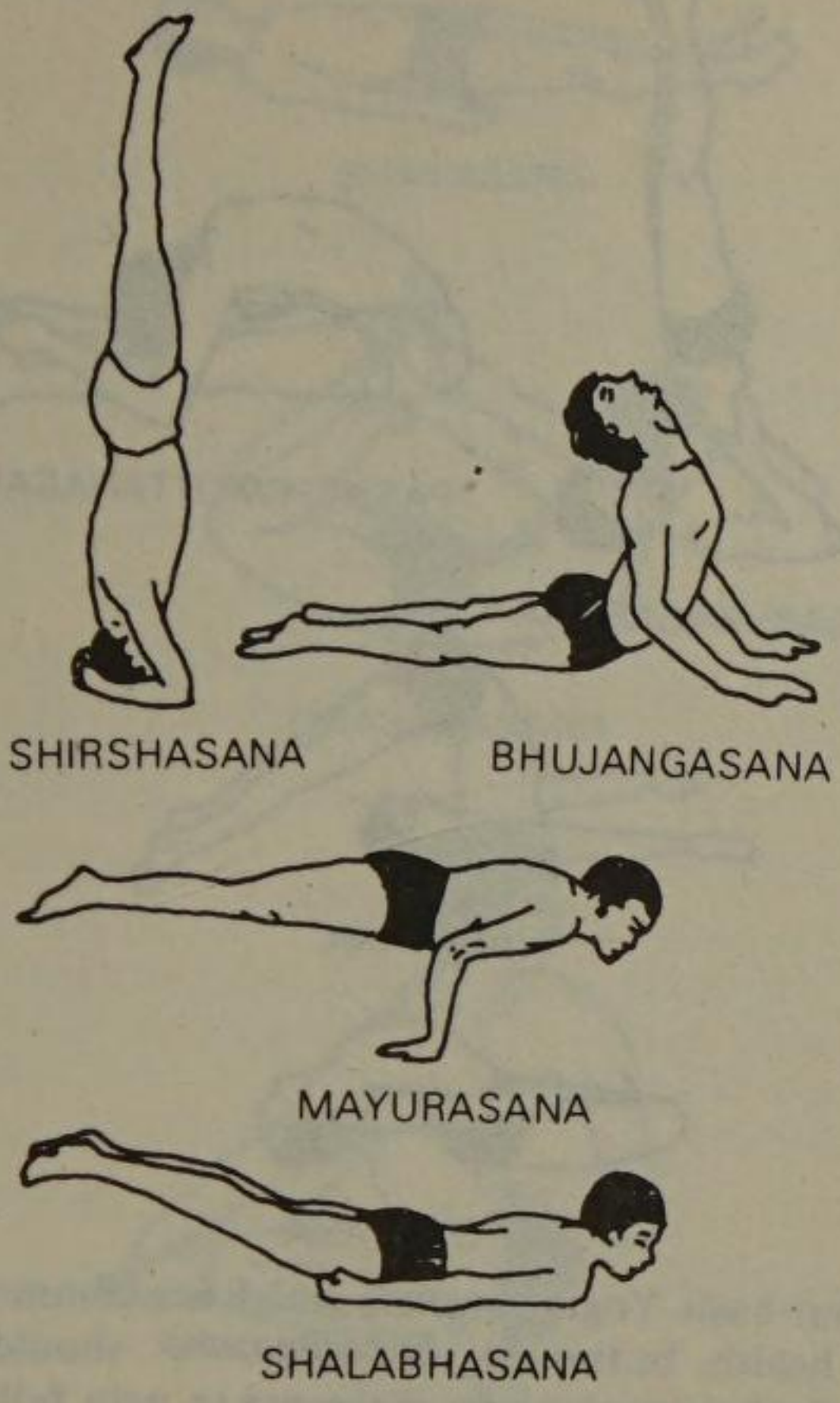


Fig. 27. Shows another set of 4 basic Yogic postures. The head-low posture, ***Shirshasana*** **should not be undertaken by elderly men as it is likely to cause** damage to the blood vessels of the brain in their case.

tion for two seconds, holding of breath for eight seconds and expiration for four second. Usually, such exersises were carried on for 20 minutes at a time with the relaxation posture for 5 minutes at the start and finish.

On two occasions we also carried out the EEG and physiological recording of a person who was actually doing *Pranayama.*

MEDITATION

In this case we could get some interesting results in terms of changes in brain waves and blood neurohumours during one hour meditation.

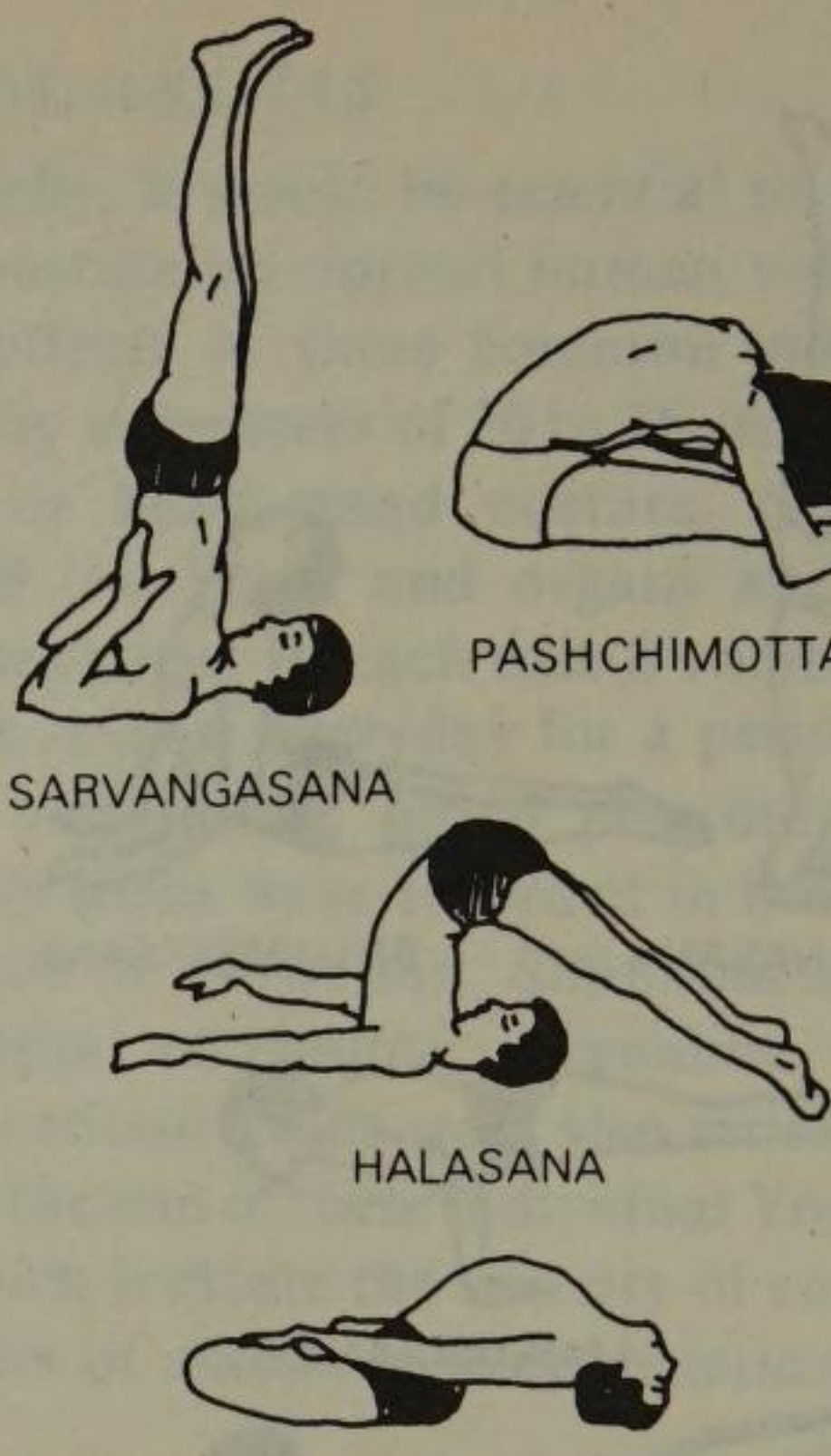


Fig. 28. Shows four basic Yogic exercises which are commonly practiced to maintain a good health. In this set *Sarvangasana* should be followed by *Matsyasana* and *Pashchimottana* by *Halasana* to gain full benefit.

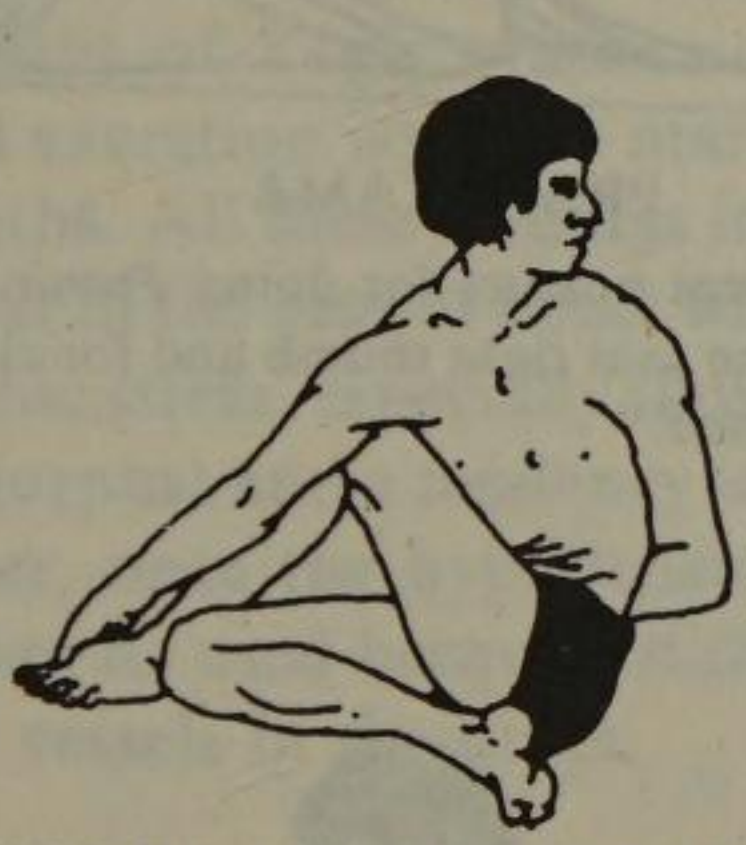
In the last group the volunteers were required to undertake all the three types of Yogic exercises, namely 8 selected *Asanas* for 15 minutes and then *Pranayama* for 5 minutes followed by meditation for 15 minutes.

EXPERIMENTAL STUDIES ON RATS

In order to study the effect of postural changes on various organs and tissue and also to assess the stress competence we conducted these studies on rats. In this study rats were kept on head stand posture in glass tubes with open ends (Fig. 32). We kept these animals in the head low posture for one hour daily upto 8 weeks. At the end of 1, 2, 3, 4, 6, and 8 weeks, various neurohumors such as acetylcholine, adrenaline, noradrenaline were estimated in the blood and tissues. The psychological

SHAVASANA

DHANURASANA

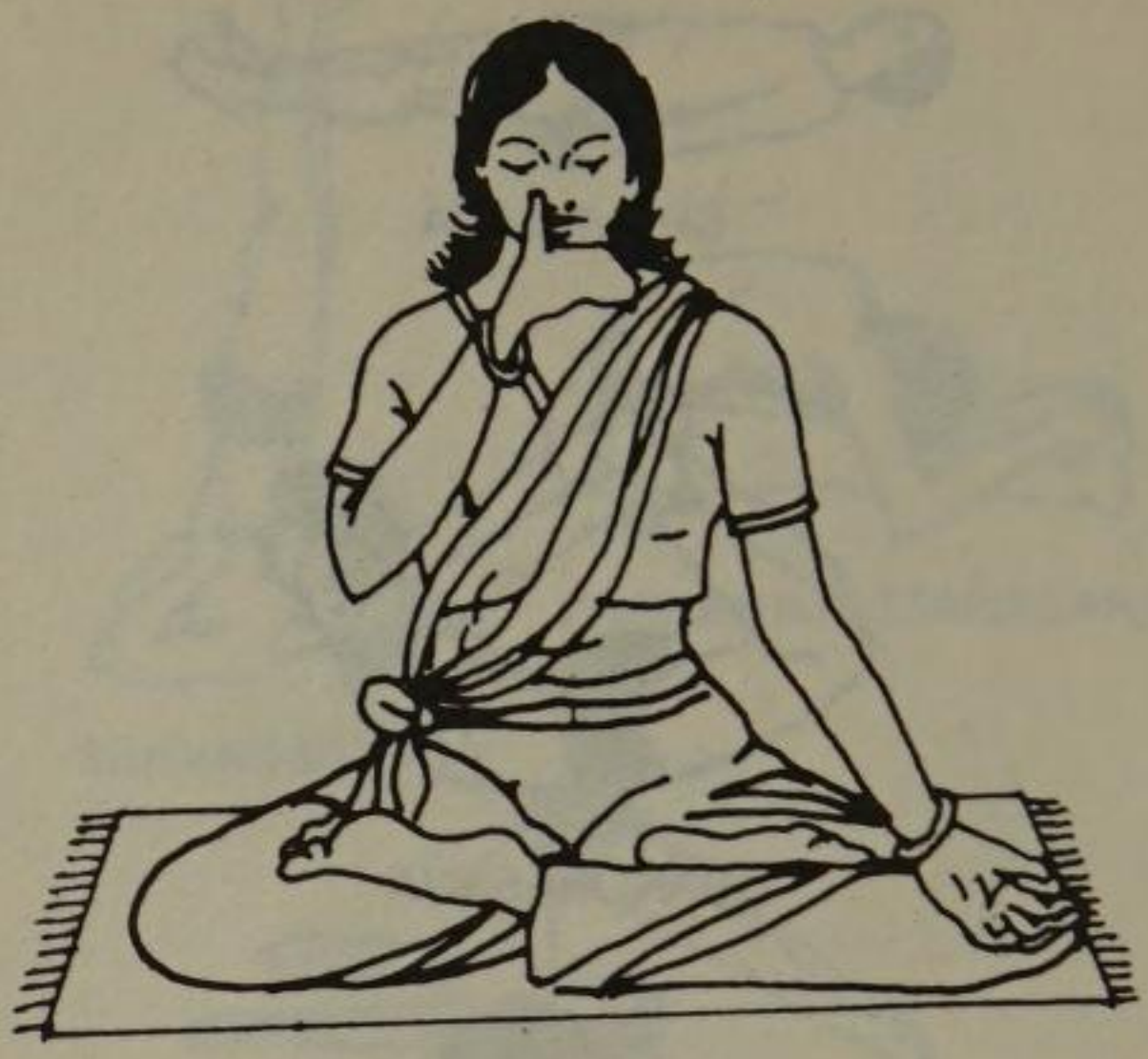


ARDHA MATSYENDRASANA

Fig. 29. A set of three additional basic Yogic postures. Here *Shavasana* or relaxation posture is an important one which should be practiced after every Yogic posture to give rest to the body. This posture has great application in the treatment of hypertension. In this case the practice of this posture alone for 15 minutes twice a day is recommended.

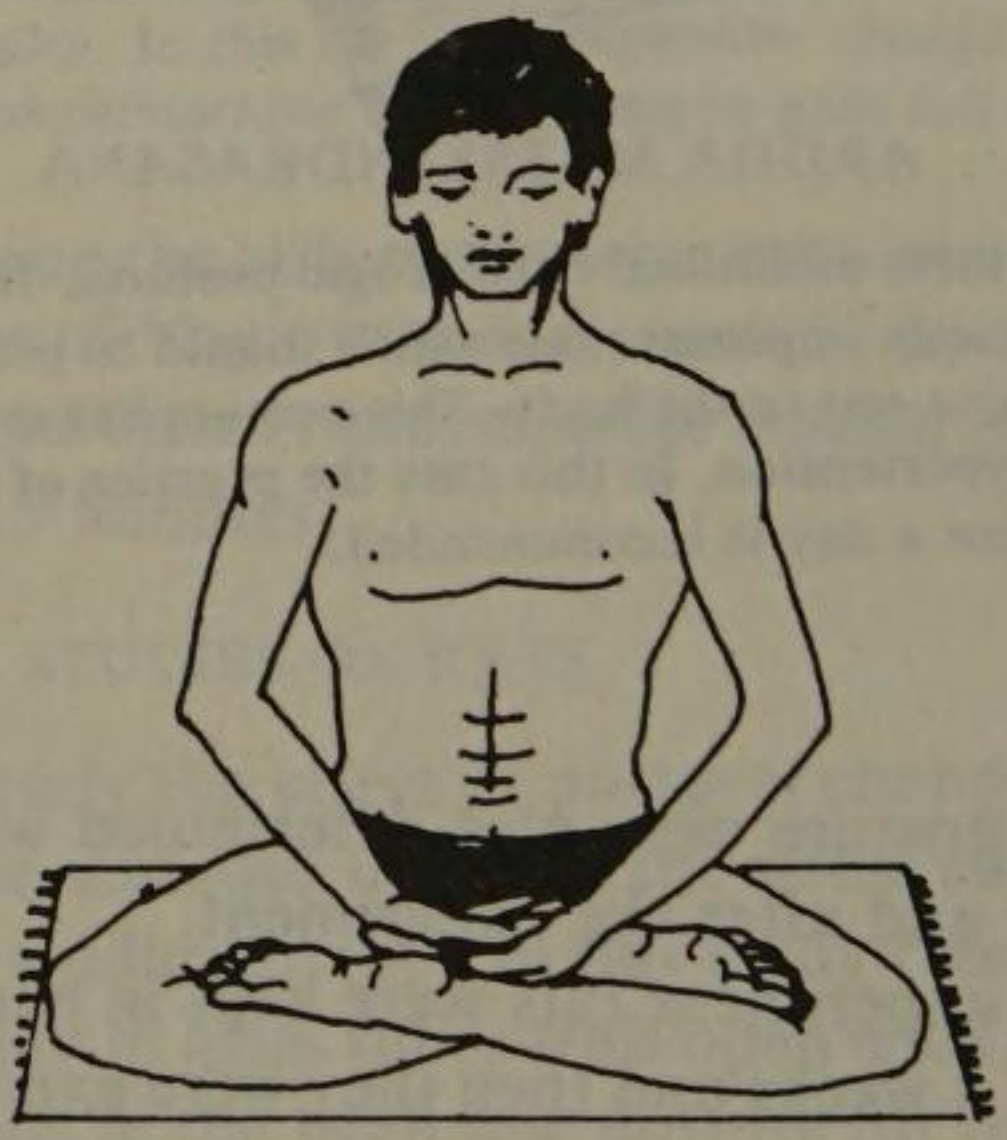
effects of this posture were also determined with the help of T-maze before and after the experiment.

In another experiment rats were kept in head low posture for a period of 4 weeks and then they were exposed to various types of acute stress such as exposure to cold, electric shock, psychic shock and immobilization stress. In these studies, the stress response of these animals was compared with that of control animals.



PRANAYAMA

Fig. 30. Shows a convenient posture for doing *Pranayama*. Note that for closing the right nostril one uses right thumb and for closing the left nostril the right index finger is used.



MEDITATION

Fig. 31. Shows the comfortable Lotus posture for doing Meditation. In addition one should have calm environment, relaxed mind and a devotional attitude while repeating a particular *Mantra*.

Physiological Studies of Human Volunteers

SHIRSHASANA

We could observe certain changes after three months' practice of head low posture with regard to blood pressure and breath holding time. The mean BP of 8 volunteers was 116/75 mm Hg before starting Yogic practice of *Shirshasana* nd it came down to 110/74 mm Hg after 3 months. Similarly, the maximum breath holding time was 69 seconds before the practice and it rose to 81 seconds at the end of 3 months of *Shirshasana*. An increase in the urinary choline and a decrease in the noradrenaline content was also recorded in these volunteers after 3 months of Yogic practice. Simultaneously, 17-hydroxycorticoid excretion was also markedly reduced at the end of three months. All these findings indicate that *Shirshasana* is more useful in the case of those who are suffering from too much of psychic stress, especially those with goods muscular body (Mesomorphs) and a tendency to develop high blood pressure. However, once the hypertension has already developed, it should not be used because of.the possible danger of rupture of blood vessels in the brain.

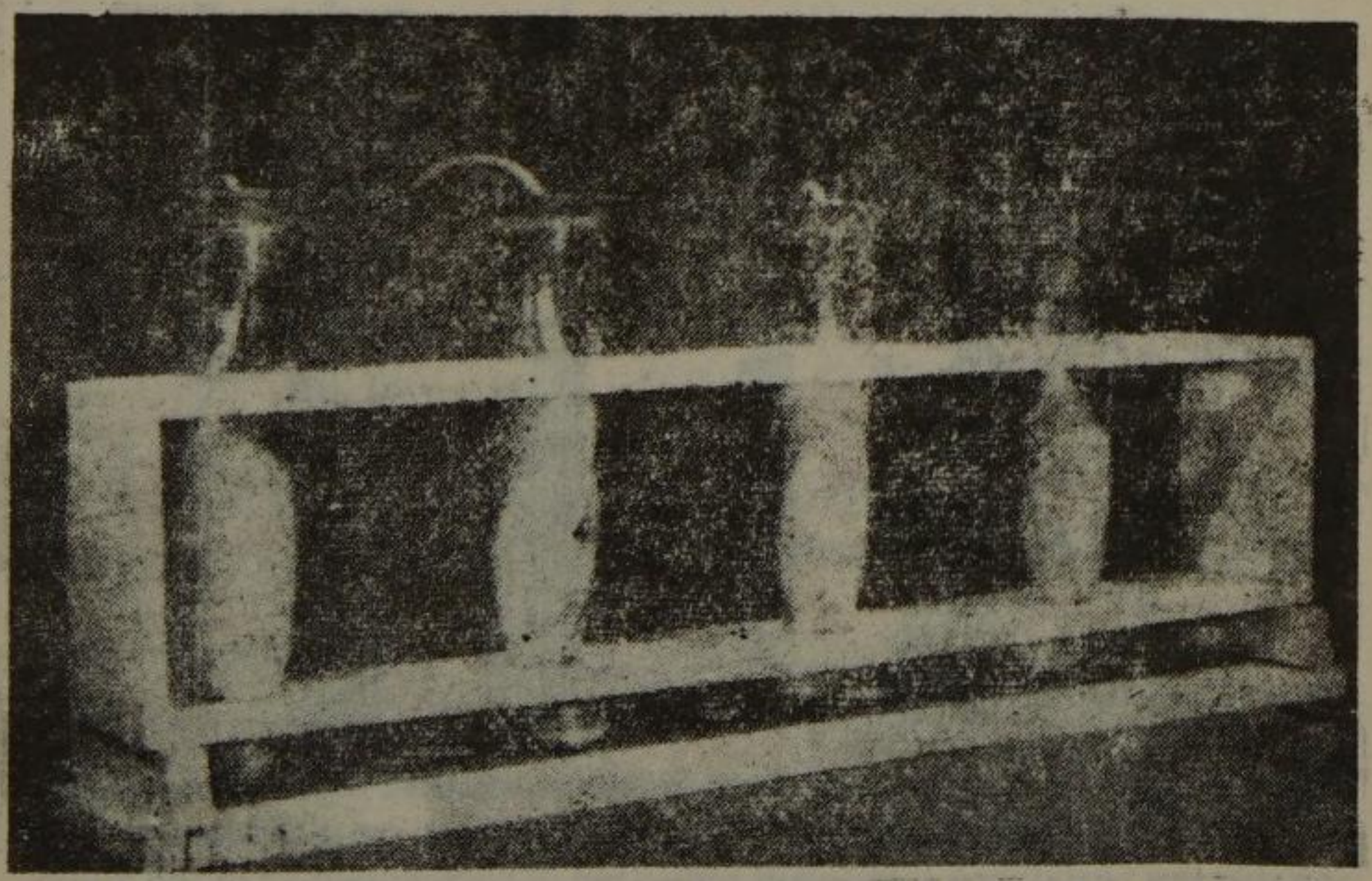


Fig. 32. Shows method of giving head-low postures to rats. They are kept in this position for 1 hour daily for a period extending upto 8 weeks.

SARVANGASANA

The most significant finding following the practice of this *Asana* was the reduction in blood pressure. Before starting this Yogic posture, the mean BP of 8 volunteers was 119/83 mm Hg. At the end of three months of practice the mean BP was significantly reduced to 108/75. The urinary exretion of neuro-humors was also reduced, though the difference was not statistically significant. Therefore, this Yogic posture can be recommended for all persons with any type of body constitution, since, it causes generalized reduction in the neurohumors.

SHAVASANA

The volunteers who practiced *Shavasana* for 3 months showed slight rise in body weight and lowering of blood pressure and pulse rate. However, statistically these changes were not significant. The most significant finding in these volunteers was a reduction in the plasma catecholamines. This indicates

PLASMA CATECHOLAMINE IN VARIOUS SINGLE *ASANAS* AND PHYSICAL EXERCISES

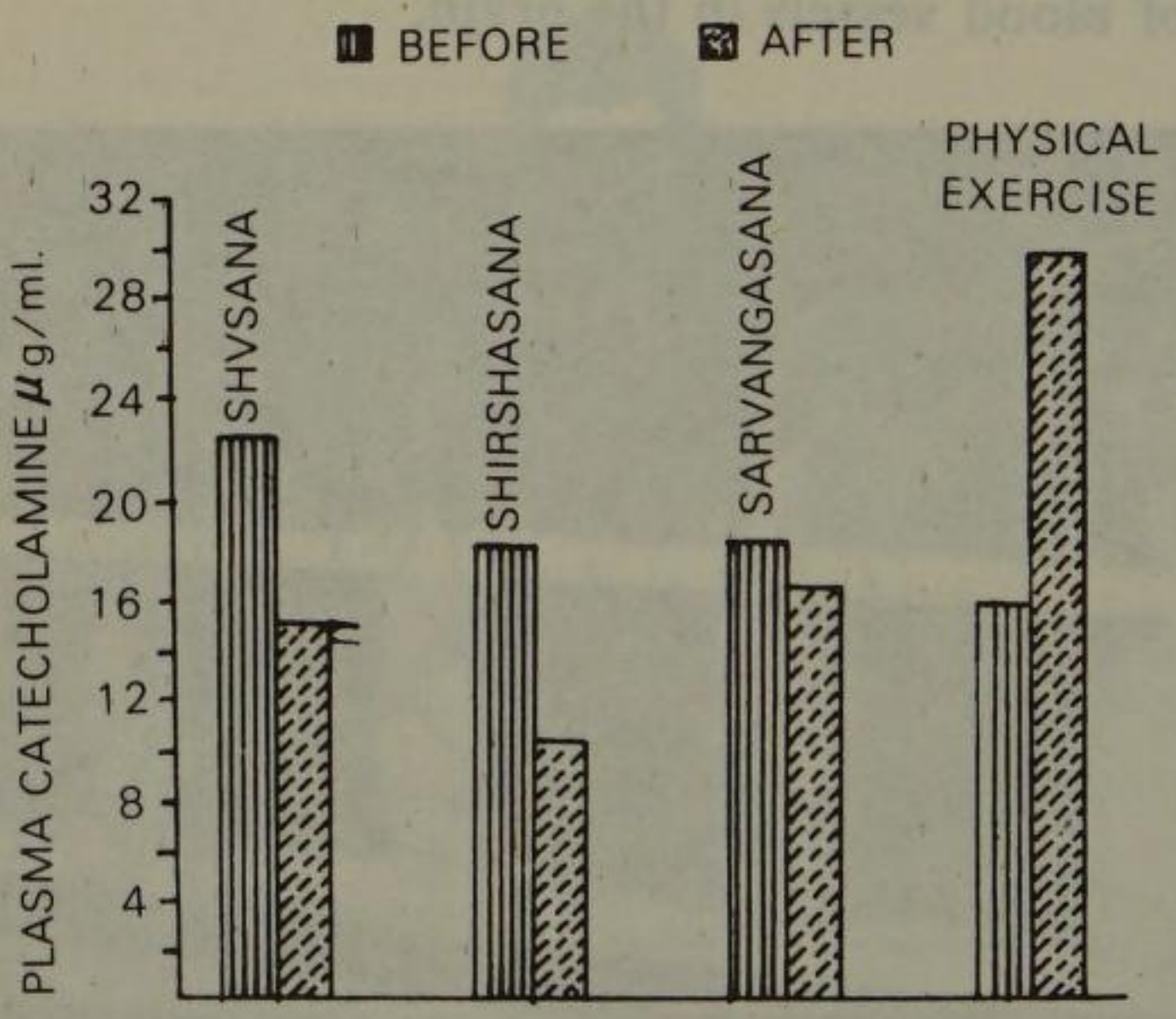


Fig. 33. This shows the plasma catecholamine content in persons undergoing 3 single Yogic postures for 3 months. As one can see, *Shavasana* and *Shirshasana* produced significant reduction of catecholamine in the blood. *Sarvangasana* did not show much change. Simple physical exercise produced marked rise in the catecholamine content of the blood.

that the *Shavasana* type of relaxation posture considerably reduces the sympathetic nervous activity. Thus, it can be used as a treatment for hypertension, in which sympathetic nervous system becomes overactive (Fig. 33).

Groups of 4 Asanas

In this, we studied the physiological and biochemical changes after the practice of 4 *Asanas* at a time and also after doing physical exercises. However, the results of these studies were not statistically significant. In fact, following physical exercises the plasma catecholamine levels increased whereas the levels were found to be relatively low in the volunteers who performed Hatha Yoga. Similarly, the acetylcholine levels were markedly reduced following Yogic exercises, but the variations were minimal after physical exercise.

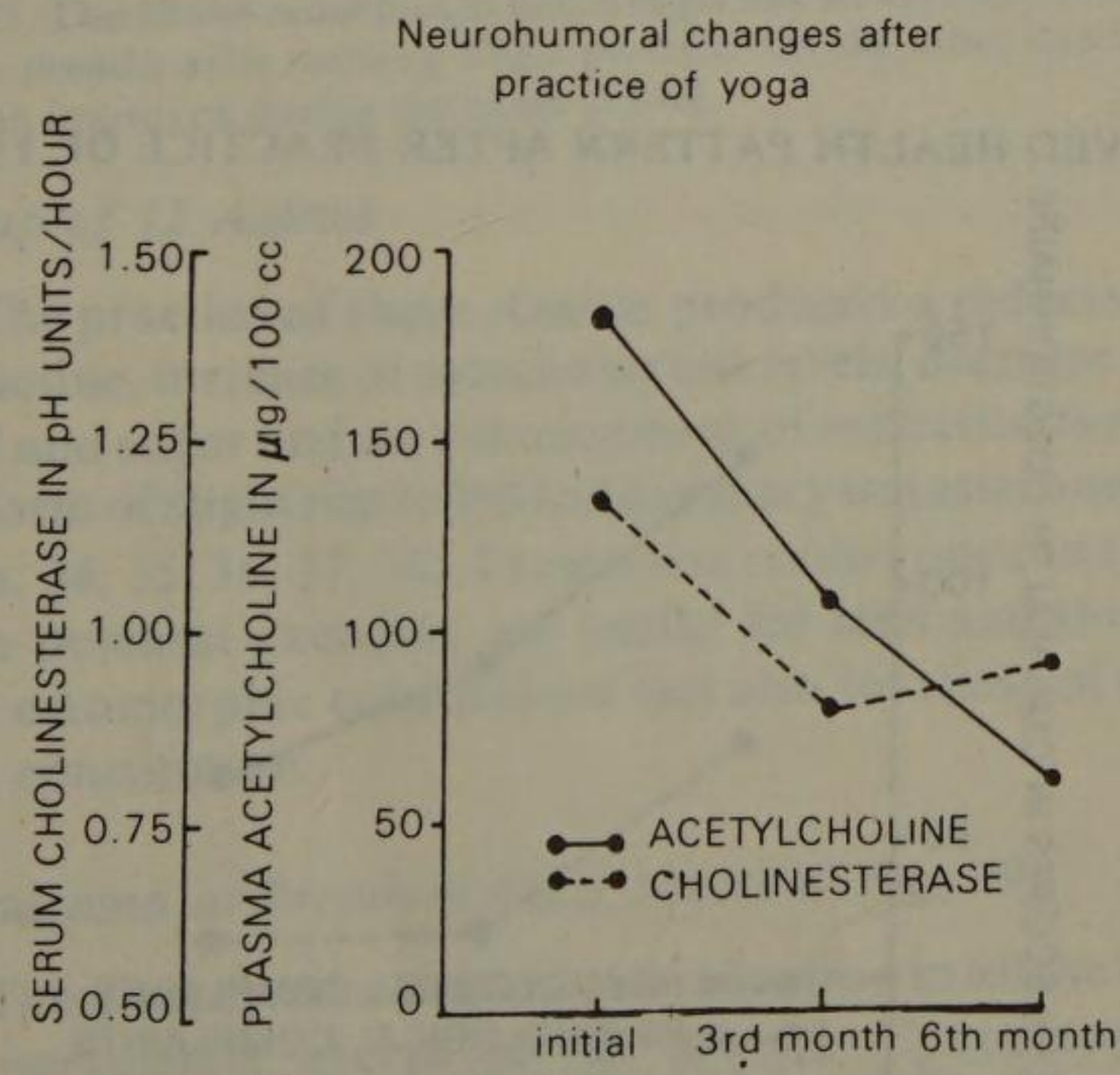


Fig. 34. This shows marked reduction of acetylcholine and cholinesterases within six months of starting Yogic practices.

MENTAL IMPROVEMENT AFTER PRACTICE OF YOGA

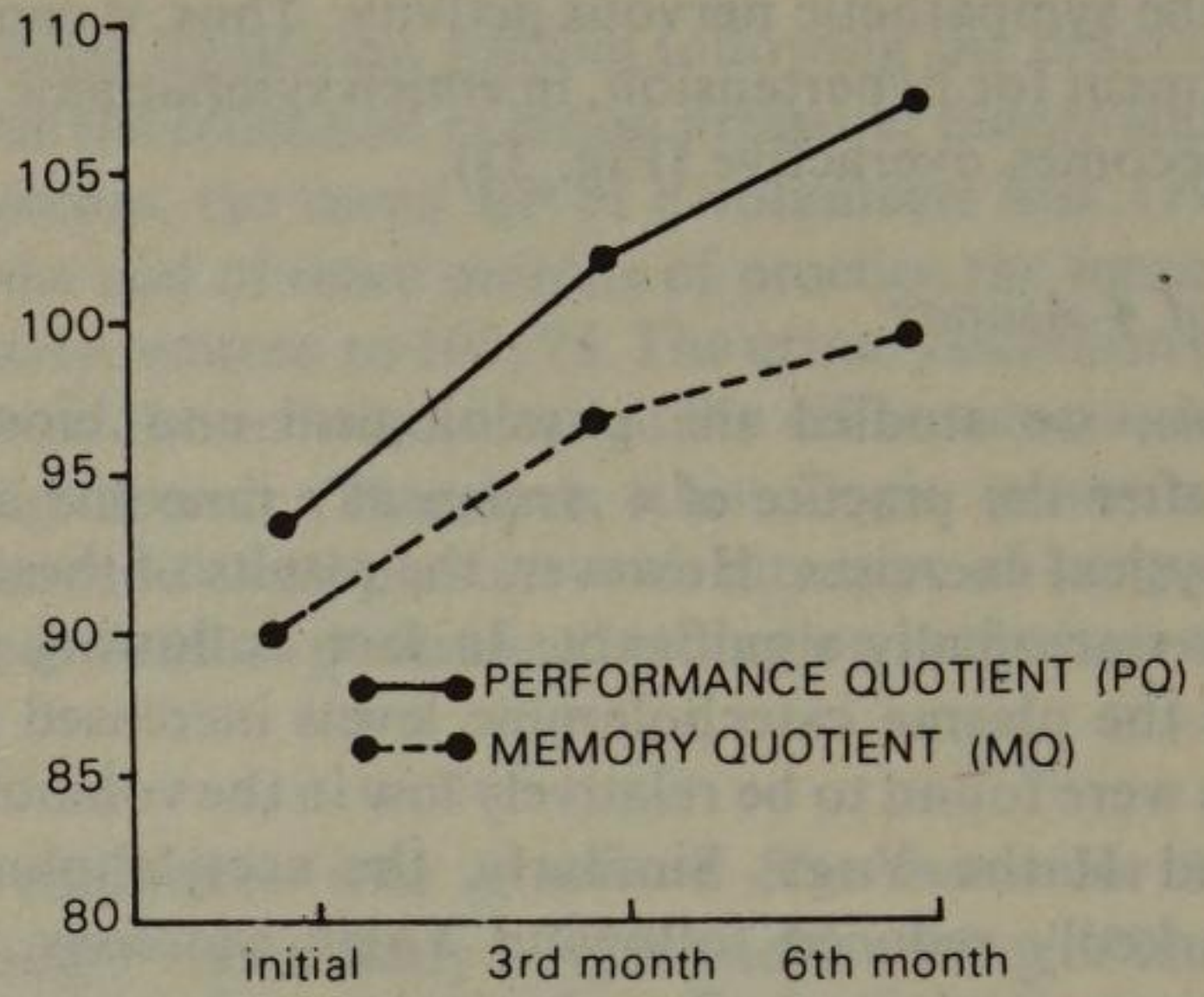


Fig. 35. Shows an improvement in the performance and memory quotients at the end of 6 months in volunteers practicing 12 basic Yogic postures.

IMPROVED HEALTH PATTERN AFTER PRACTICE OF YOGA

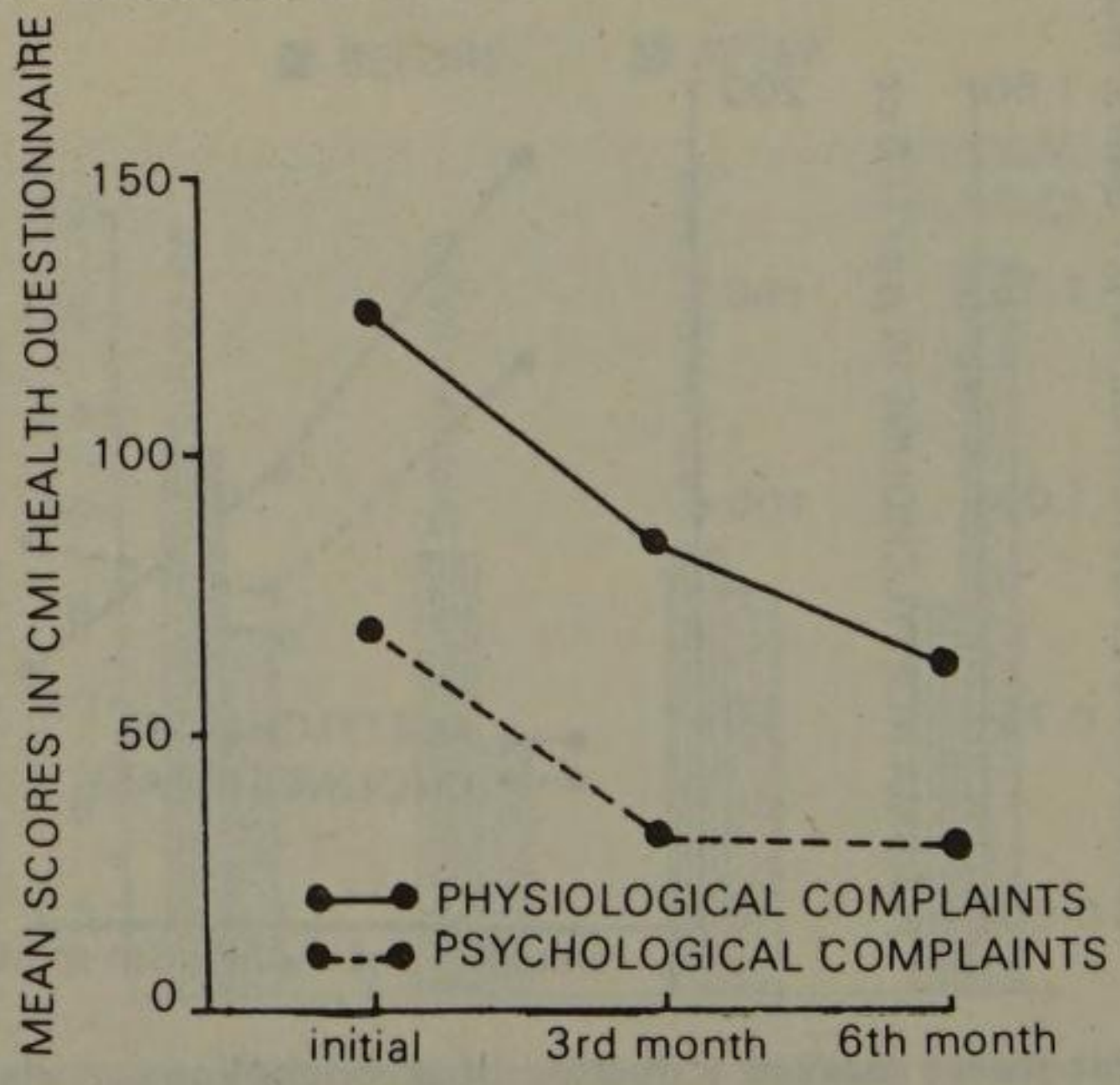


Fig. 36. Shows psychological improvement after the practice of 12 basic *Asanas* for six months. Here one can clearly see a reduction in psychological and physiological complaints to a minimum level.

SOME GROSS METABOLIC CHANGES AFTER PRACTICE OF YOGA

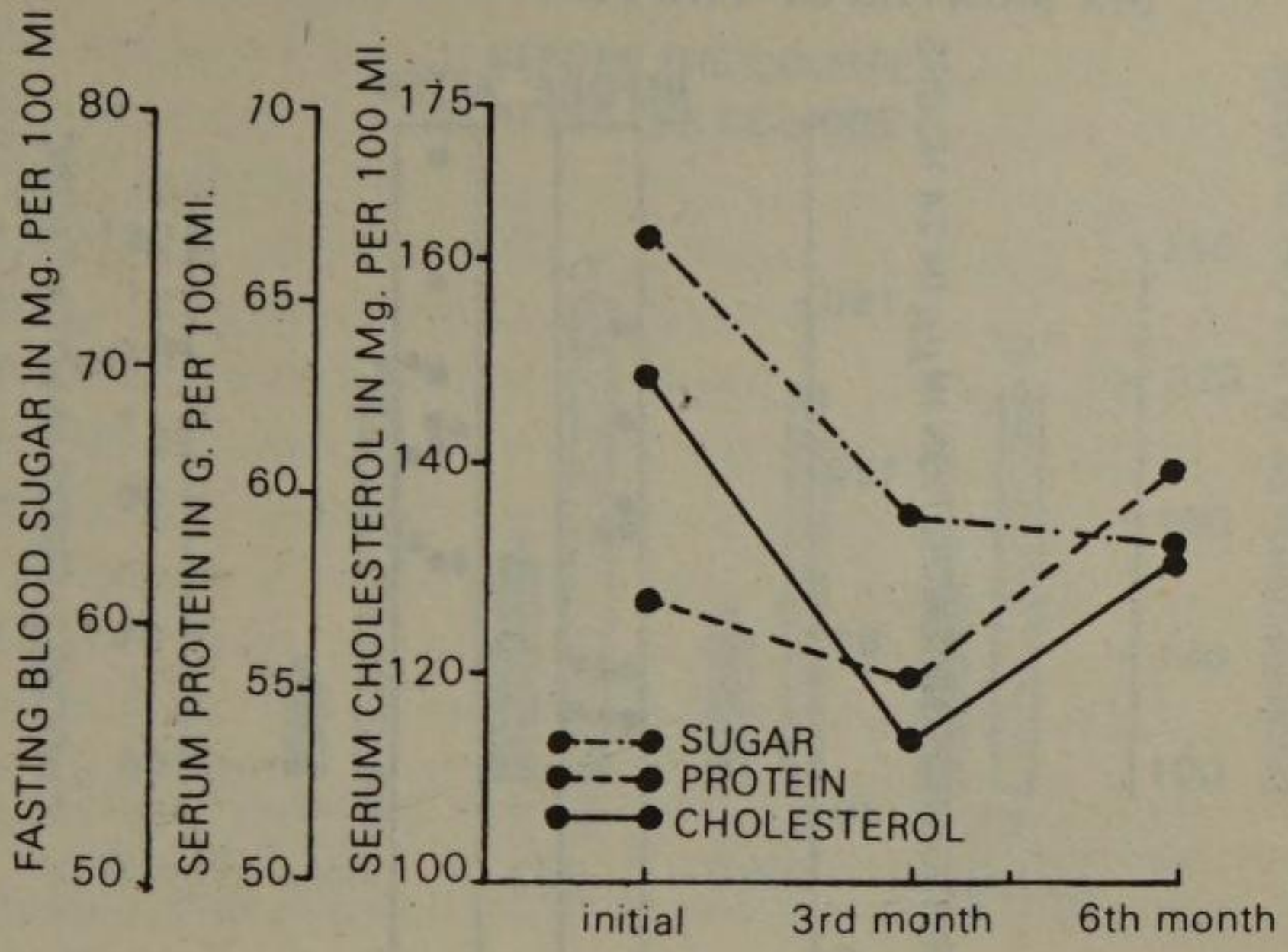


Fig. 37. This shows reduction of blood sugar and serum cholesterol at the end of six months after starting Yogic practice. On the other hand, the serum protein improved during the same period.

Group of 12 Asanas

The practice of these *Asanas* produced a reduction of acetylcholine, increase of catecholamine levels, decrease of cholesterol and sugar and an enhancement of endocrine functions, in the form of slight rise in PBI and urinary testosterone excretion (Figs. 34, 35, 36, 37, 38). From these studies one can say that all these postural exercises are useful for lean and thin persons with ectomorphic constitution and also for those of endomorphic constitution.

Pranayama or breath holding practice (Fig. 39)

There occurred a generalized reduction in all the biochemical parameters except in the urinary 17-hydroxycorticoid which was found increased. Otherwise, serum cholinesterases, plasma catecholamines, serum lipids, serum cholesterol and blood sugar were all found reduced at the end of six months of breath control practice. This indicates that *pranayama* produ-

URINARY EXCRETION OF TESTOSTERONE BEFORE AND AFTER SIX MONTHS OF THE PRACTICE OF YOGA

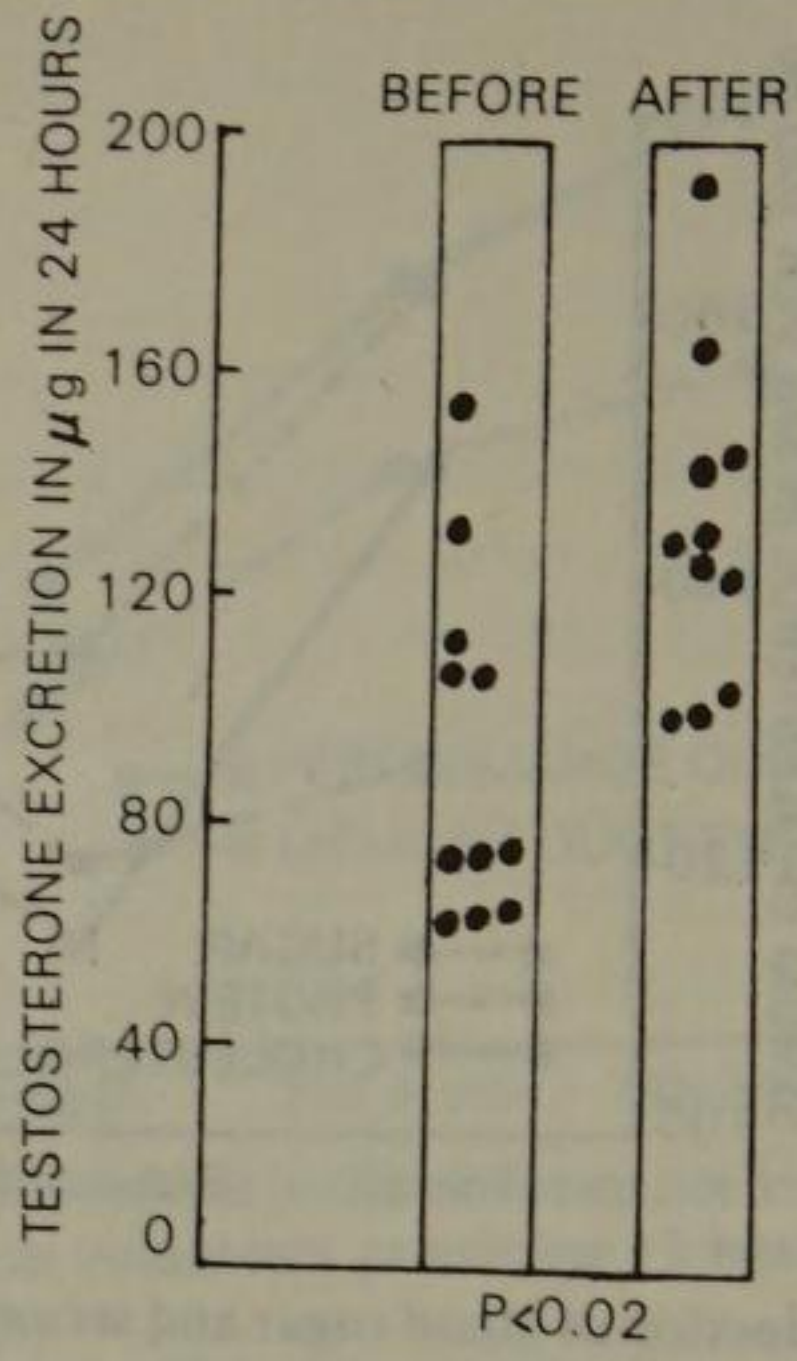


Fig. 38. This shows the urinary excretion pattern of testosterone before and after the practice of Yoga for six months. Note that urinary excretion of testosterone after Yoga practice increased considerably indicating considerable improvement in the endocrine function of testes.

TECHNIQUE OF PRANAYAMA

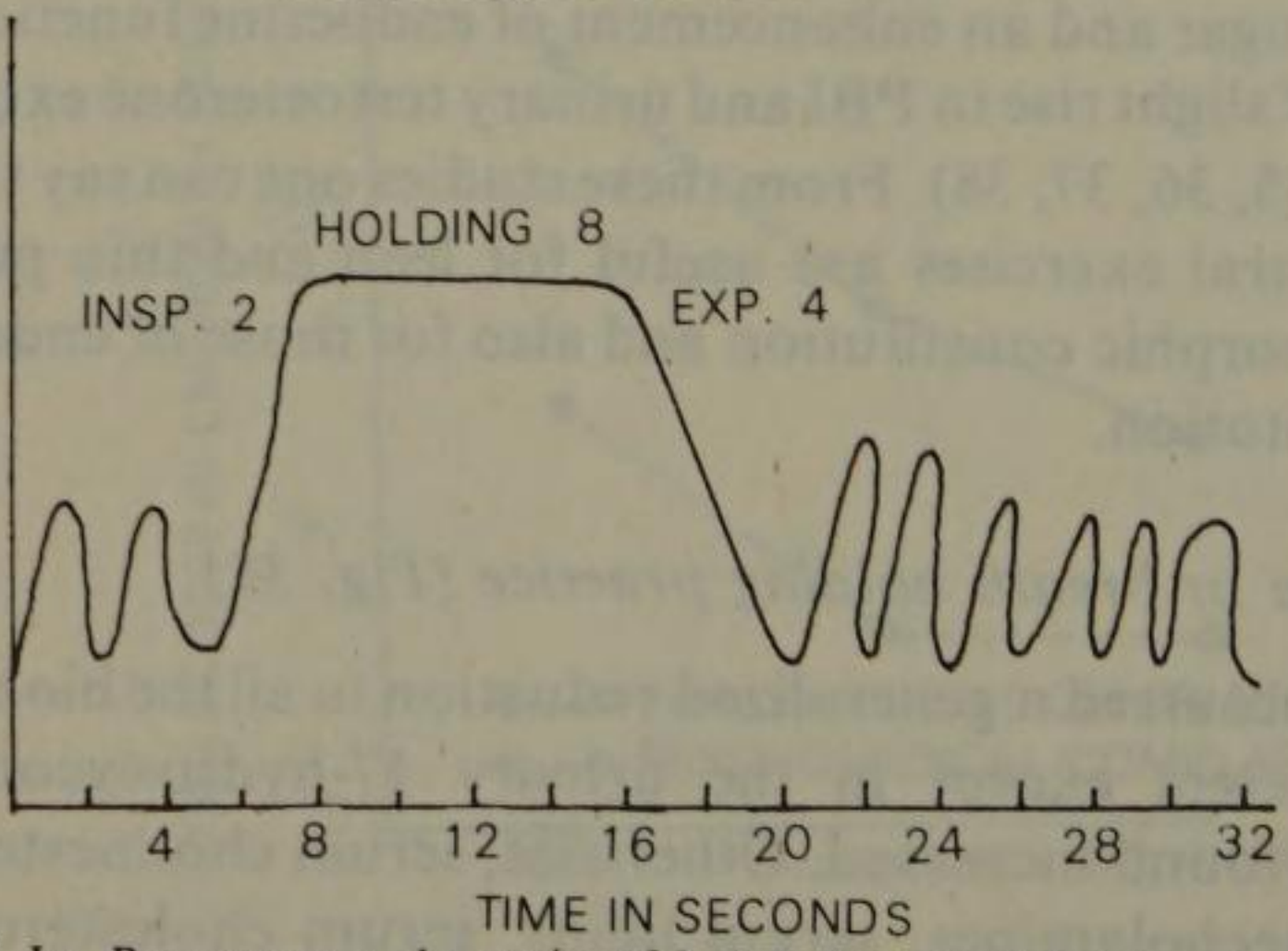


Fig. 39. In *Pranayama* the ratio of 2, 8 & 4 seconds for inspiration, holding the breath and expiration is recommended. This is the commonly accepted ratio.

NEUROHUMORAL CHANGES AFTER A COURSE OF MEDITATION

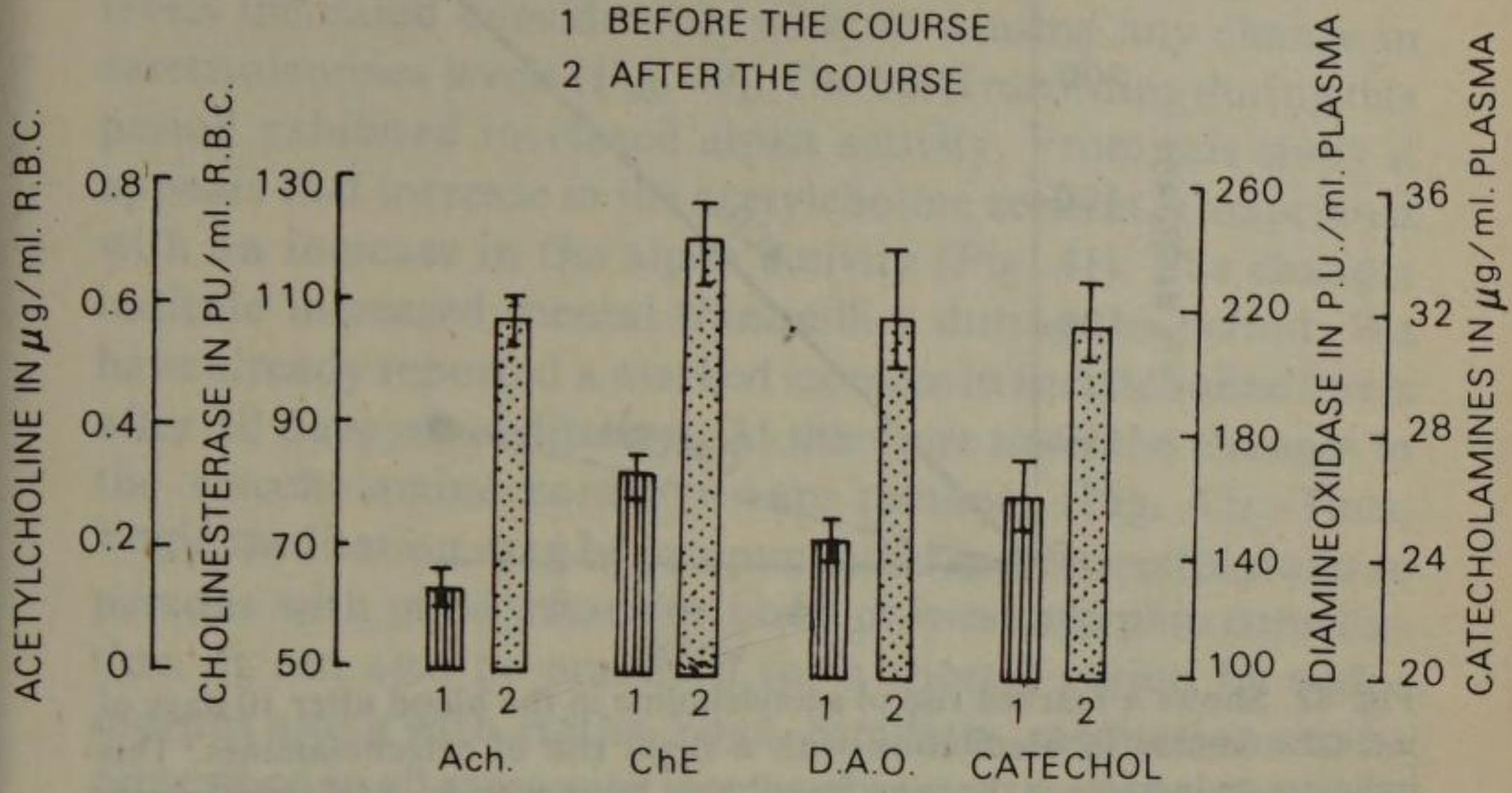


Fig. 40. Shows marked increase of various neurohumors after 10 days' intensive practice of *Vipassana* type of Buddhist Meditation. This indicates higher capacity for doing intellectual work after such Meditation.

NEUROHUMORAL CHANGES FOLLOWING MEDITATION

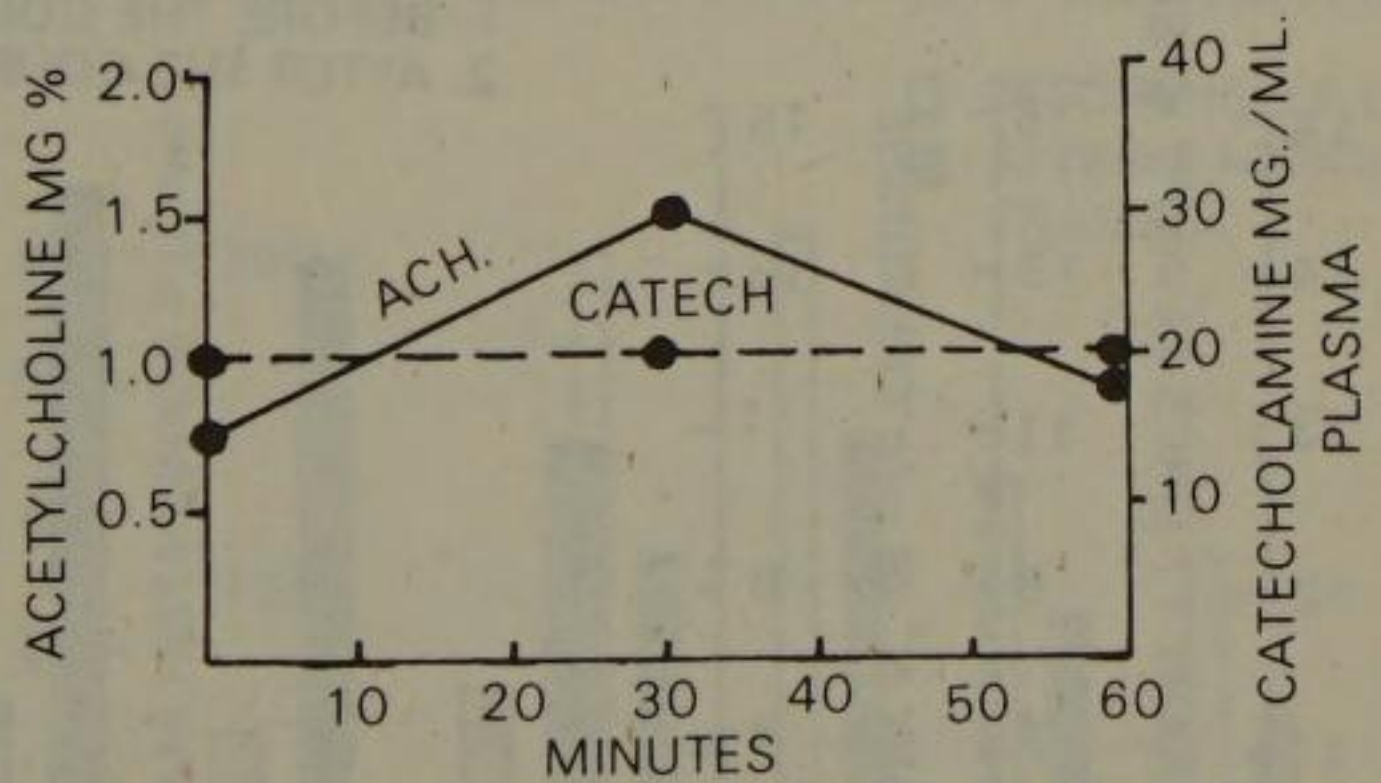


Fig. 41. Shows Neuro-humoral changes during Meditation. Here one can see a slight rise of Acetylcholine in the blood during Meditation whereas there was no change in catecholamine content.

ces a good effect on all the organs and tissues and helps in maintaining their activity at the optimum level. The EEG studies during *pranayama* revealed increased alpha waves throughout the period which tend to suggest enhanced mental tranquillity of the person during the period.

NEUROHUMORAL CHANGES FOLLOWING MEDITATION

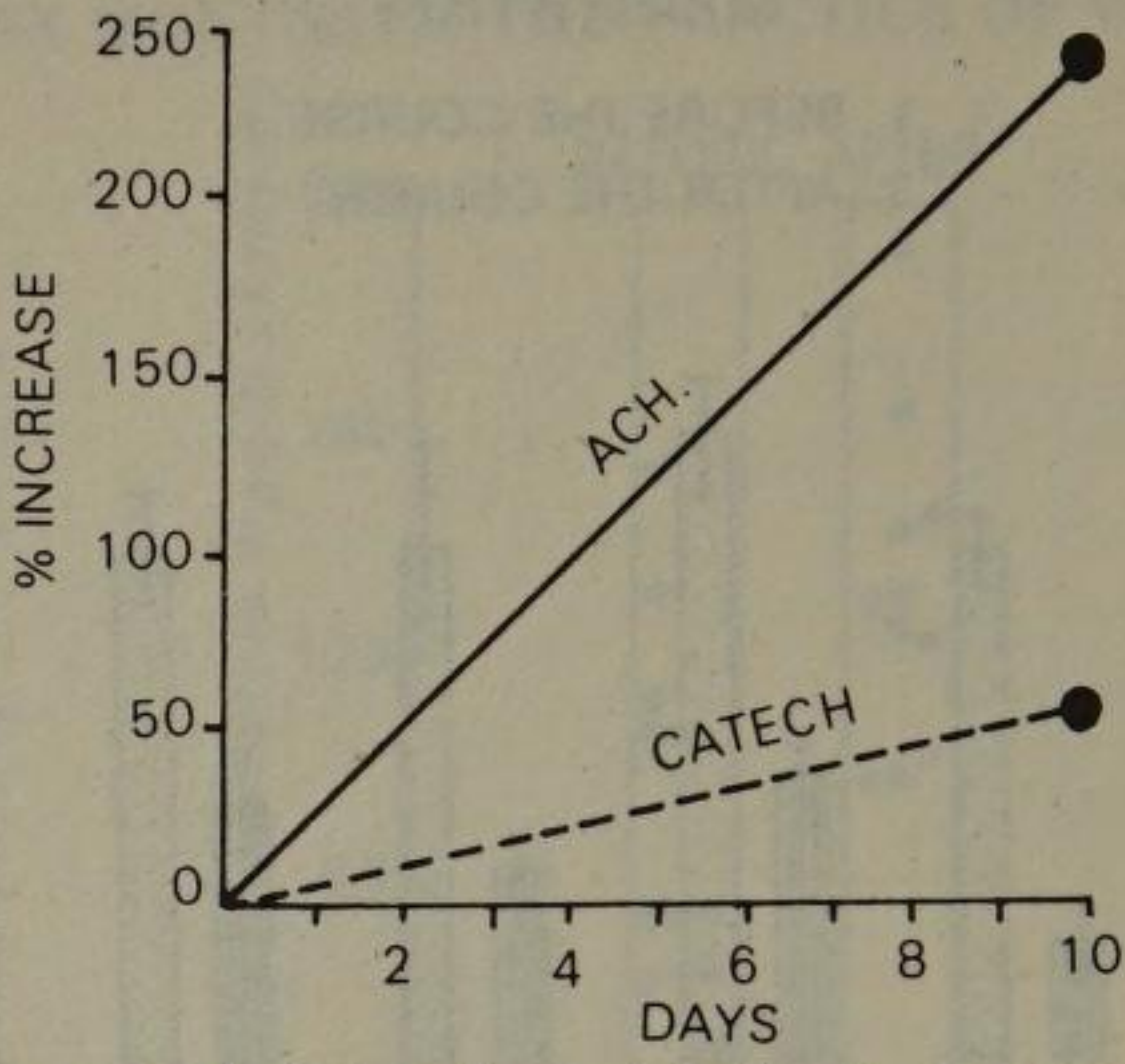


Fig. 42. Shows a marked rise of acetylcholine in the blood after 10 days of intensive course in Meditation with a slight rise of catecholamines. This indicates an increase in the capacity of these persons to do intellectual work.

ENDOCRINE AND METABOLIC CHANGES AFTER A COURSE OF MEDITATION

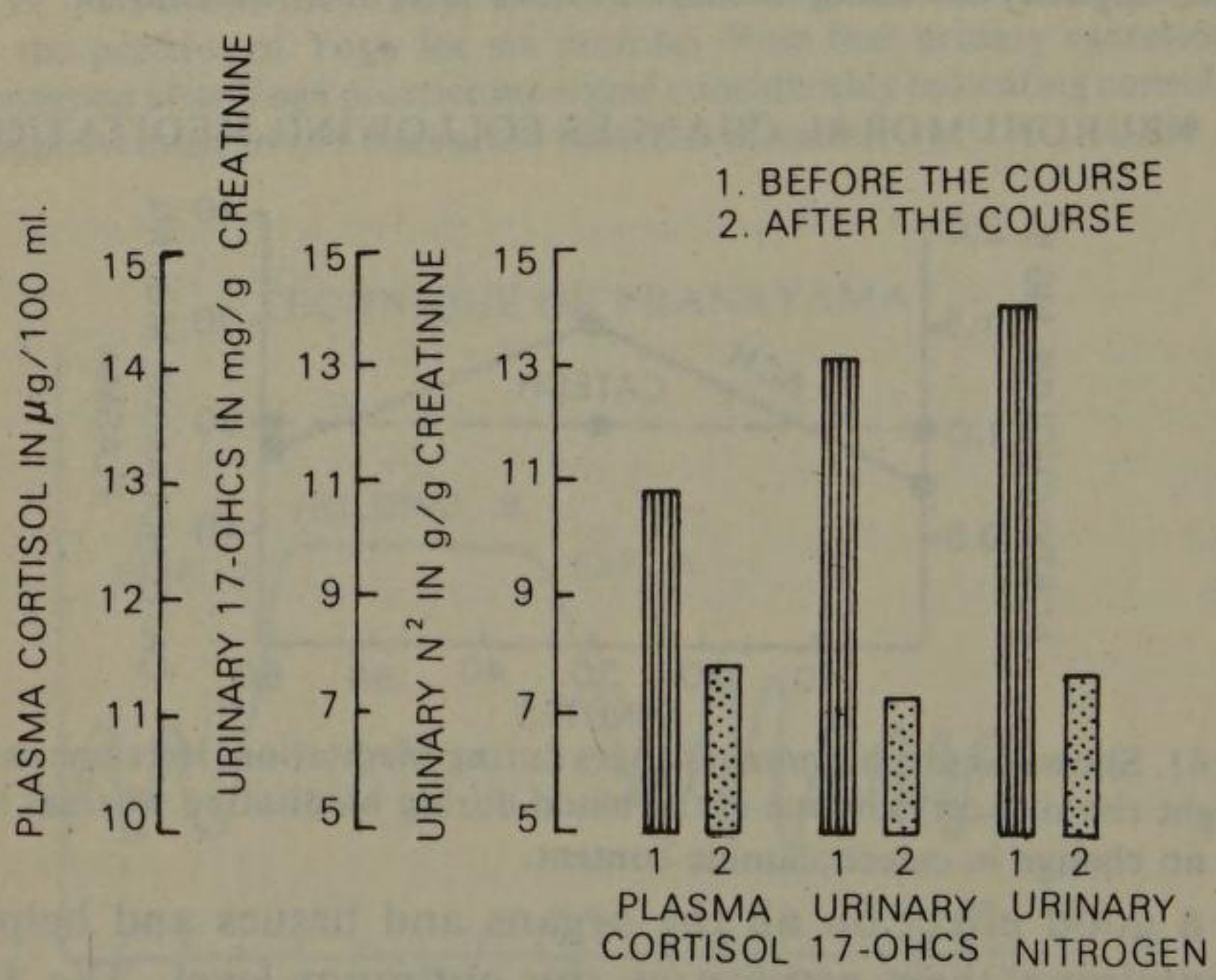


Fig. 43. Shows metabolic and endocrine changes after Meditation. Note a considerable reduction in plasma cortisol, urinary hydroxycorticoids and urinary nitrogen after a course in Meditation.

MEDITATION

During one hour of meditation the blood acetylcholine levels increased considerably without causing any change in catecholamines levels (Fig. 40). The EEG recording during this period exhibited increased alpha activity. From this study it appears that increase in the acetylcholine content is associated with an increase in the alpha activity (Fig. 41). The changes indicate increased mental tranquillity during the period. We have already reported a marked increase in acetylcholine levels after 10 days of meditation. At the same time, the changes in the catecholamine contents were minimal (Fig. 42). Thus, Yogic meditation may be recommended in all stressful states to persons with good muscular body or mesomorphic constitution. It can also be practiced for a shorter period by endomorphs along with Hatha Yoga. Similarly, meditation can be prescribed in all cases with increased sympathetic activity, such as hypertension and other functional disorders of cardiovascular system.

BIOCHEMICAL CHANGES FOLLOWING A SELECTIVE COMBINED PRACTICE OF YOGA FOR 3 MONTHS

(POSTURE, BREATHING EXERCISES AND RELAXATION)

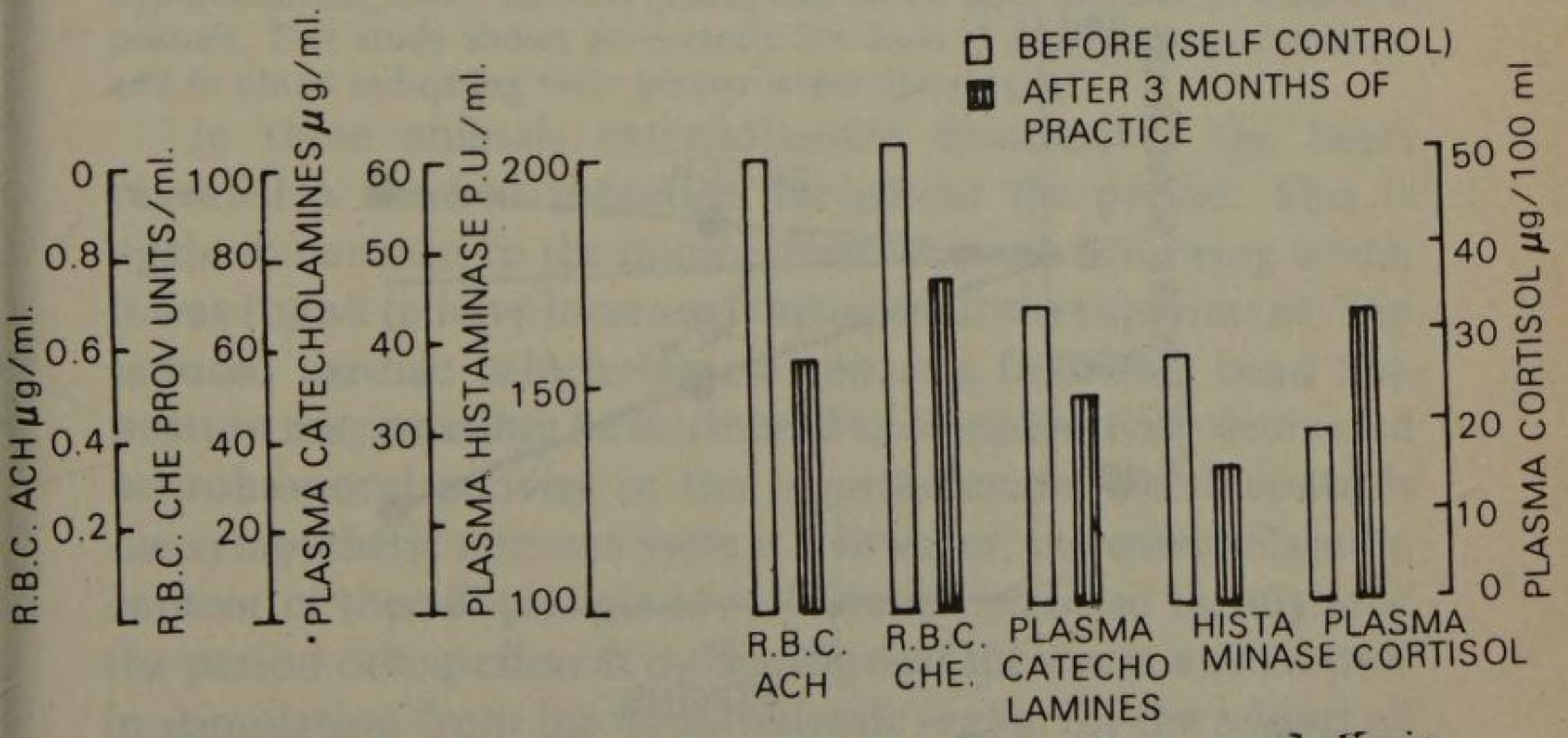


Fig. 44. This shows the result of a combined practice of Yoga, namely Yogic postures, *Pranayama* and relaxation type of Meditation for 3 months. Note a marked reduction of all the three neurohumors and a slight rise of plasma cortisol indicating a better stress competence of these persons.

In view of these physiological and biochemical studies, we now generally prescribe all these Yogic exercises either individually or collectively for the treatment of various stress disorders with varying biochemical and neurohumoral disturbances. Our clinical studies of 400 patients fully corroborate these physiological studies conducted on normal healthy vounteers (Fig. 43, 44).

Experimental Studies

It was interesting to note that in the cerebral cortex, thalamus and hypothalamic region of the brain the catecholamine contents increased in the first 4 weeks of head-low posture followed by normalization in the remaining 4 weeks. This is in contrast to immobilization stress where the brain catecholamine contents remained high throughout. This further confirmed that these animals got adjusted to stressful situations more quickly than the controls or those who received immobilization stress.

NEUROHUMORAL CHANGES AFTER A COURSE OF *ASANAS* [POSTURES]

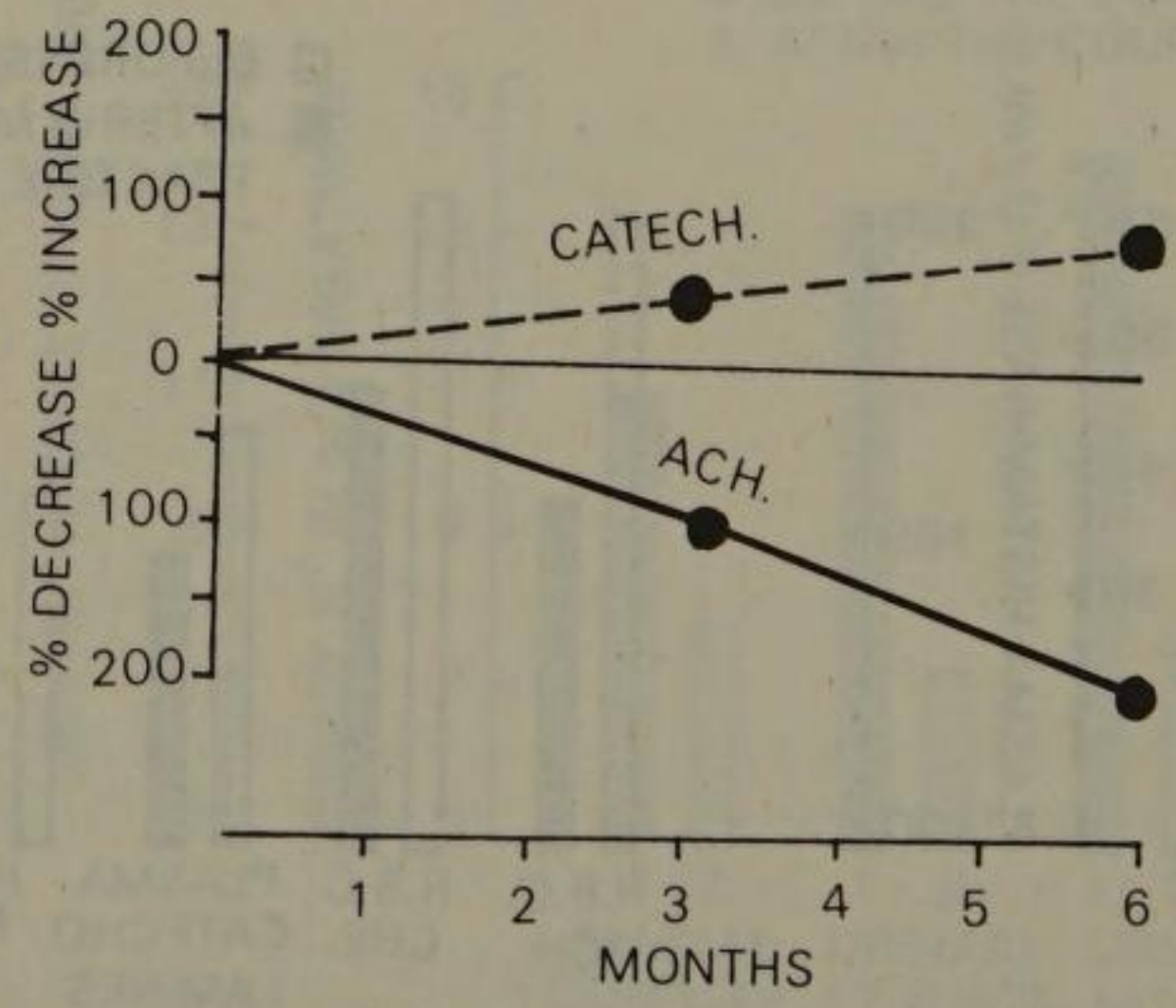


Fig. 45. Shows changes in acetylcholine and catecholamine after practising 12 Yogic postures for six months. There is a marked reduction of acetylcholine in blood indicating an optimum level of acetylcholine in brain. Note a slight rise of catecholamine in these people, which is not of much significance.

CATECHOLAMINE LEVELS IN HEAD-LOW POSTURE

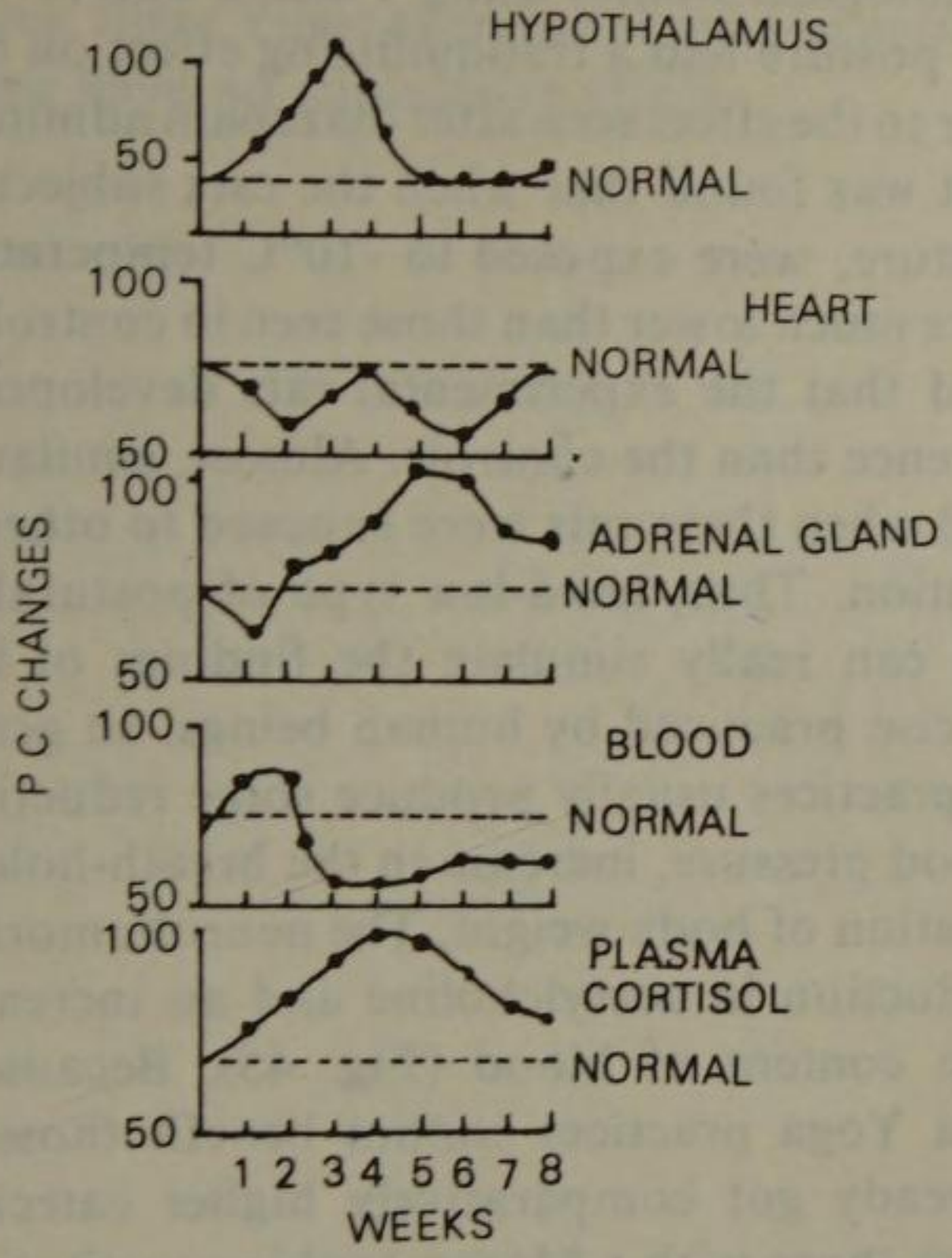


Fig. 46. Shows levels of catecholamines in different areas of the body, such as hypothalamus, heart, adrenal gland, and blood after practice of head-low posture. This study shows persistently low level of catecholamines in heart and in blood indicating their greater stress competence.

In these animals catecholamine contents of the heart revealed a marked reduction throghout the period. This is again in contrast to the immobilization stress following which it was found to have increased throughout the experiment. The reduced cardiac catecholamine contents following head low posture may possibly be attributed to comparatively decreased neurohumoral activity in the hypothalamus, which controls the sympathetic nervous system. However, the catecholamine content of the adrenal gland was found increased throughout the period of experiment indicating that there was a reduction in stimulation from the hypothalamic region for the release of catecholamines from that gland. Possibly as a result of it the plasma catecholamines and cortisol also remained low throughout the period of experiment (Fig. 46).

The psychological studies using T-Maze also revealed that the head-low posture had a tranquillizing effect on the brain, almost similar to the effect seen after diazepam administration.

Further, it was found that when the rats subjected to the head-low posture, were exposed to -10°C temperature, their responses were much lower than those seen in control animals. This indicated that the experimental rats developed greater stress competence than the controls. Almost, similar findings were observed when these rats were exposed to other types of stressful situation. Thus, head-low type of postural exercise given to rats can really simulate the findings of head low postural exercise practiced by human beings. In general, the Hatha Yoga practices usually produce some reduction in the pulse and blood pressure, increase in the breath-holding time and normalization of body weight. The neurohumoral studies indicate a reduction in acetylcholine and an increase in the catecholamine content of blood (Fig. 45). Because of this usually Hatha Yoga practices cannot benefit those persons who have already got comparatively higher catecholamine content such as those with a Mesomorphic constitution. They can be useful to those who have more of acetylcholine in the body, such as persons having an ectomorphic constitution.

Meditation usually increases acetylcholine and does not increase catecholamine. Hence, it can be practised with benefit by people having mesomorphic constitution. Meditation can also be practiced by people having endomorphic constitution together with *Hatha Yoga* exercises especially *Pranayama* or breath control.

Our experimental studies of rats with head-low posture fully corroborate our human studies (Fig. 46). As stated earlier, it reduces catecholamine content of heart and also of blood. It was also found to increase stress competence of the animals and therefore it may act as a tranquillizer. Hence, from our human physiological and experimental studies, we can say that these Yogic practices play a great role in increasing stress competence of human beings. This would ultimately lead to perfect balance of the psychosomatic apparatus of man, giving

rise to peace and tranquillity throughout the period.

However, these Yogic exercises should be performed everyday, as they have no cumulative effect.

CHAPTER 12

Meditation

Dhyana or meditation is one of the most important components of Patanjali's integrated practice of Yoga (Fig. 47). At the same time, one should realize that it is difficult to master the technique of meditation. Further, there are several methods of meditation and hence one is liable to get confused about the proper method he should adopt to derive full benefit out of such a practice. Some of these aspects are discussed below for a proper understanding of the problem. One should remember that for successful meditation, the mind must be calm and for this we must conduct our normal life in peaceful manner. Generally, a prayerful attitude in relation to work would be most useful. Further, we must realize the fact that divinity in some degree is present in every individual that we come across. This ultimately leads to peaceful life which in turn helps us calm our mind while we sit for meditation. In order to keep our mind in a peaceful state we should keep our body also in sound state of health. For this, we must have a balanced amount of food, good sleep and regular habits with regard to our work and recreation. When a person manages to have such a steady and healthy body and mind, he can easily sit for meditation in a comfortable posture in a calm atmosphere. Therefore, he resorts to Prayer and *Japa* (repetition of a holy name) in order to develop mental concentration on the divine consciousness. Meditation along with the repetition of a *Mantra* should, as far as possible, be practiced at a fixed time of the day, preferably in the morning and evening with empty stomach. Many people can practice meditation even without a *mantra*. In general, repetition of a *mantra* is better way of doing meditation. In this regard Swami Bhavyanand states:

"Such aspirants after preliminary preparations for Meditation can start with Japa with slightly sounded whisper. Later, it will refine itself into a repetition done silently in the mind. As a result of continuous practice of the mantra, the mind becomes steady and concentrated and ultimately we feel the presence of God. In that state there is only an awareness... One simply experiences the peace and joy of the awareness of God."

Continuing he says: "Prayer, in which can be included reading, repeating and dwelling upon Hymns and Scriptures containing noble and elevating thoughts helps very much to prepare our minds for Japas and Meditation. We find that in every religion prayers form a fundamental part of the literature. As an aspirant grows spiritually, a prayerful attitude naturally develops in him.... Whenever we feel weak, God is the ready source of strength. In our moments of severe testing and turmoil which no human being can altogether escape, God is the one being to whom we can and should look for support". In this way, if we practice meditation we gradually develop confidence in ourselves and in our sipiritual practice. Then the state of mental concentration becomes more natural and automatic.

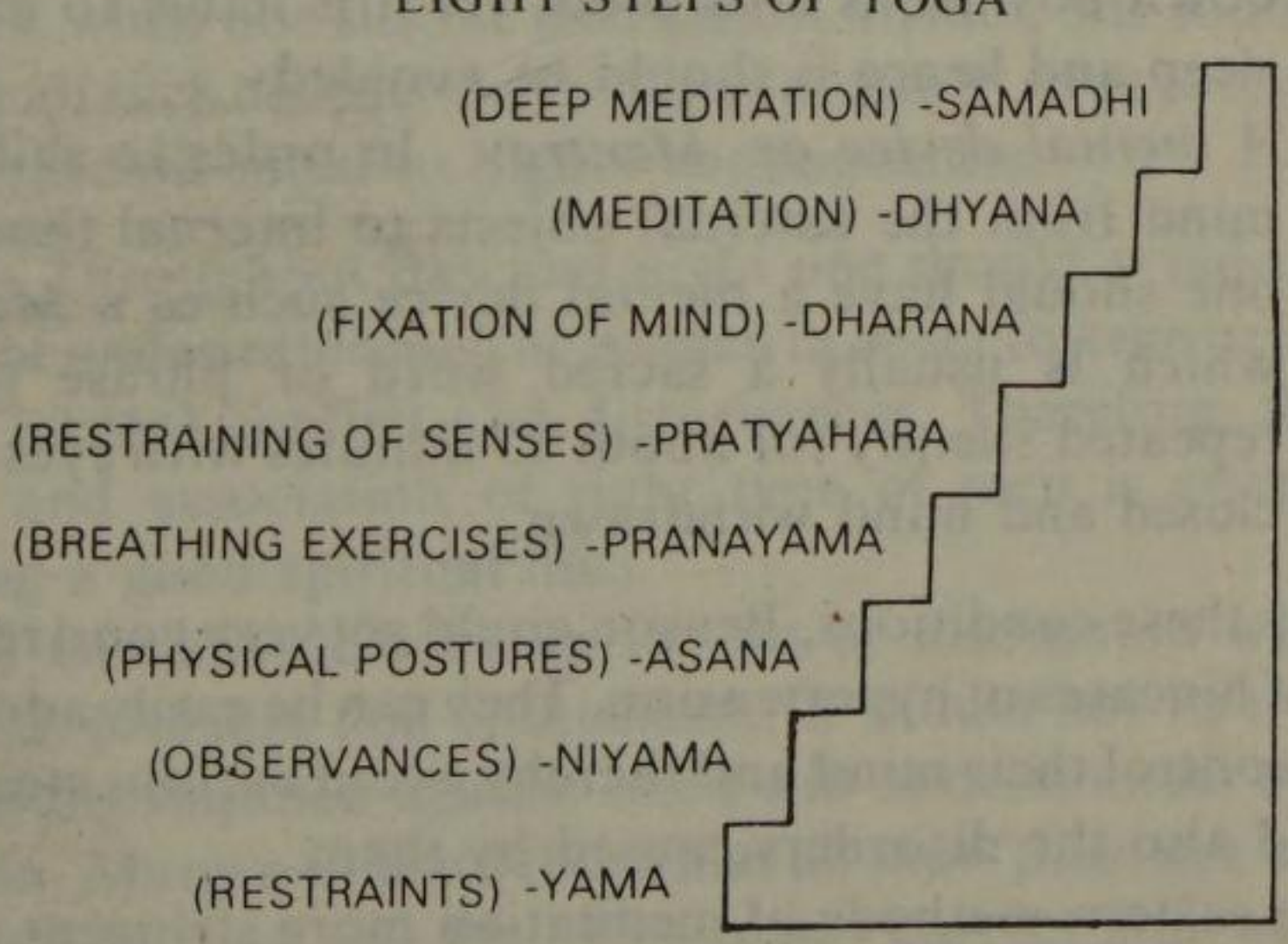


Fig. 47. This shows the eight steps of Yoga which have been prescribed by the sage Patanjali. Unless one follows and practices all of them together in an integrated manner one will not be able to derive the full benefit from Yoga. The first two are related to social and personal behaviour, 3rd and 4th are yogic exercises. The last four are stages of Meditation.

REQUIREMENTS FOR MEDITATION

Herbert Benson, as Associate Professor of Medicine at the Harvard Medical School, Boston, USA has done extensive work in this field from the Western point of view. He calls it "*Relaxation Response*", which is nothing but a modern version of meditation. In order to practice this effectively four essential things are required:

(1) *A quiet environment:* For this, one is required to have a quiet room, as one usually keeps for worship. This greatly helps in minimizing distraction.

(2) *A passive attitude:* This is the most important thing in eliciting the relaxation response. One should not bother about any disturbing thoughts that come to his mind; he should let the matter go away and then concentrate on his practice.

(3) *A comfortable position:* This is important to prevent undue muscle tension in the body. Any posture that would give a person maximum relaxation, such as the cross-legged lotus posture, is good. Though lying down posture is also good, yet it is liable to induce sleep and hence it should be avoided.

(4) *A mental device or Mantra*: In order to shift the mind from the external objects to internal thought, one should have a mental device such as a *Mantra* which is usually a sacred word or phrase to be repeated silently for about 15 minutes with eyes fully closed and mind withdrawn.

Under these conditions, Benson could get very good results in most of his cases of hypertension. They can he easily adopted by all to control their mind and thereby avoid various stressful states and also the disorders caused by them.

In the eastern methods of meditation more stringent techniques have been prescribed. According to Swami Ashokananda, the following points have been laid down for meditation:

(1) From the very beginning, we must make a firm resolution that we would practice very regularly at a fixed time every morning and evening. Although, there can be many distractions in the routine of our daily life, we should faithfully practice meditation whatever else may be going on in and around us. In fact, meditation should be as much a part of life as breathing.

(2) We must have a fixed time for meditation and normally every person should practice meditation twice a day in the morning before sunrise and in the evening after sunset. Some people prefer to do meditation at noon time and also at night before going to bed. Whatever may be the time suitable for each individual, the observance of regular hours of meditation is very important because the mind usually functions according to habit.

(3) One should also practice meditation at a fixed place. Many people prefer to practice meditation in the prayer halls of churches or temples.

(4) One should try to forget all passions, impulses, and desires, when one sits for meditation. In fact, one should try to forget all such distractions as far as possible, so as to enable one to elevate his mind to higher consciousness.

(5) Throughout day and night one should avoid the company of undesirable men or women in order to keep oneself free from mental conflict and disturbances. Therefore, the company and association of right type of men is essential for leading a good spiritual life.

(6) One should take up the art of meditation with great interest, pleasure and enthusiasm. It should not be treated as something imposed against one's will or done under any compulsion. Many a time we think that all these practices belong to the later part of our life. This is not correct and we should adopt them at the earliest opportunity, especially when we are liable to be exposed to too much of stress and strain of life. One should prepare oneself well mentally and physically before he undertakes the practice of meditation at a regular time at a fixed place for a given period of time.

WHAT IS *MANTRA*

Mantra is a sacred word or group of words the repetition of which is supposed to lead to spiritual attainments. This is usually done in conjunction with meditation. The word "*Om*" is the commonest *mantra* which is considered as the essence of all the Vedas and Upanishads. One can repeat slowly this word hundred times in 10 minutes, during which he should concentrate his mind in the middle of the forehead in between the two eye brows for the next 5 minutes. Just as for meditaton, so for repeating *Mantras* also one should sit in a comfortable position with erect posture, keeping head, neck and chest in a straight line. Then one should carry on his prayer for a few minutes followed by repetition of *Mantra*. Apart from the repetition of "*Om*", in the Indo-Aryan culture, worshiping of sun through *Gayatri mantra* is also being practiced by many people. Since this involves instruction by a Guru we do not want to discuss this matter further. Suffice it to say here that one can repeat any *Mantra* like "*Om*", *Gayatri* or any other sacred word which one can adopt and repeat everyday. But, it must be repeated every morning and evening preceded and followed by meditation. These are some of the basic things in meditation. If one wants to know more about it, one should dive deep into it and also personally discuss these matters with experts in this field.

CONSCIOUSNESS AND MEDITATION

Consciousness is nothing but the awareness of ourselves and also of the universe around us. The mind consists mainly of constant flow of thoughts and it has four functions. It receives information from the environment; then it relates that information to our previous experiences and makes it a part of our personal experience; it further analyses and makes judgments on the basis of our new experience; ultimately it deposits the information in the vast store house of our memory.

Consciousness is something much higher and more powerful than the mind. It actually watches the mind. It is the self or "I" which is constantly watching the activities of the mind. It is this which is known as 'Atman', the inner self. Swami Muktananda states, "Meditate on yourself, honour yourself and God dwells within you as you". It is this which can be called individual consciousness. It should be remembered that it is a part of the universal consciousness dwelling in the individual. In fact it is nothing but a small segment of the cosmic creative energy, which is present throughout the universe.

According to yogic philosophy there are four states of consciousness: (1) waking state, (b) dreaming state, (c) dreamless sleeping state, and (d) *turiya* state or state of superconsciousness in which we attain a silent and pure awareness. According to Aurobindo the future evolutionary process of human beings would be marked by the attainment of different degrees of superconsciousness by the individuals. But according to Western scientists and psychologists, the future evolution of human beings is dependent upon the development of a strong healthy ego (*Ahankara* in yogic tenminology). For Eastern or yogic psychologists, however, achievement of healthy ego with endless wave of thoughts, impulses and desires, is simply one more stage in our journey to achieve the highest goal of superconsciousness. Such an ego which is one of the external activities of the mind is an important instrument necessary for functioning in the modern world, but we should realise that through it alone we can never make an evolutionary progress in future life.

According to Yoga experts one must learn to know the self, by directing our mind to look towards our inner self which lies beyond all thoughts and desires. In fact such a search ultimately leads to the realisation that our inner self or individual soul is not a separate entity, but a part of God or universal consciousness.

Thus realisation of self is the most important state to be achieved by the process of different types of meditation. Once such a realisation of self occurs by this simple means, one can

gradually proceed further to attain the superconscious state by enlarging the sphere of his activity.

This feeling of pure self, other than the mind is the most basic fact which one will have to realise. Many of the philosophical, psychological, and sociological concepts of personal identification of "self" may be quite valid personal attributes. But the pure self is quite different from all these concepts and images. Peter Russell describes this state of consciousness in the following manner while describing the subject of Transcendental Meditation of Maharshi Mahesh Yogi: "The only way to know the pure self is by systematically reducing the impact of sensory experience until only self remains... In this state there is no longer any experience of 'I am this' or 'I am that'. There is not even the experience 'I am'. It is simply a state of is-ness or pure being. It is a field which lies beyond individual consciousness and for precisely this reason there is an absence of individuality. If there is any feeling of identity, it is one of universality or at-one-ness with the whole of creation. The boundaries which usually serve to distinguish our self from another having dissolved, there is no longer any effective means of distinction. One begins to experience that at the most fundamental level, 'we are all one and the same' and the pure self is a universal self which shines through different nervous systems and takes on the form of an individual consciousness and individual self".

The experience of such a being is difficult to attain by ordinary means. But by meditating on it constantly one can attain that state gradually in one's life time. It is the central theme of all our Upanishads: "What is within us is also without, what is without us is also within". Similarly Jesus Christ also declared: "The Kingdom of God is within you". The meaning of all the statements is the same, i.e. that the self is part of universal consciousness. However the attainment of such an experience is not an easy task, as one will have to experience and practice for a prolonged period preferably under the guidance of some trained person. It is here that a study of the ancient Vedas, Upanishads, the Philosophy of Yoga greatly

helps us to have a correct conception of the self, Atman, or consciousness on which one can gradually meditate and achieve the goal. Let us consider how to meditate on our self or on our individual consciousness to achieve the goal of universal consciousness.

TECHNIQUE OF MEDITATION

It is always good to have a fixed place for meditation. One should preferably have a special room. Otherwise a corner of a living room will be enough. One should put on basic minimal clothes and sit on a mat especially prepared for the purpose. As far as possible one should meditate at the same time everyday. The early hours of the morning between 4 and 6 A.M. are supposed to be the best for the purpose, though one can meditate at any convenient time of the day or night. There are many methods of meditation recommended by several great sages. The *Bhagavad Gita* has described the technique in some detail in the sixth chapter. Buddha has given his instructions for meditation in a simple form known as *Vipasyana* Meditation. In this one has to concentrate on his own breathing. In recent years Maharshi Mahesh Yogi has popularised *Transcendental Meditation* all over the world. Similarly Swami Muktananda has been advocating *Siddha Meditation* Technique in recent years which has proved much useful. He described his technique in great detail in a simple language and the same is given here as a first choice.

"Just as you slip easily into sleep you should be able to slip easily into meditation. Sit peacefully; be with yourself; focus your mind on the inner consciousness, the inner knower. Let your breathe move naturally and watch it. Do not force anything. Become immersed in your own inner self. Turn your mind and senses inwards. Absorb yourself in the pure 'I'... To help in stilling the mind, you may take the support of a *mantra*. Repeat either '*Om Namah Shivaya*' or '*Soham*'. The meaning of the former is 'I bow to the Lord who is the inner self'. The meaning of the latter *mantra* is 'I am that' which allows you to experience the self".

He continues: "The purpose of meditation is inner happiness, inner peace. When all the senses become quiet and you experience bliss, that is the attainment. The world is the embodiment of joy. Joy lies everywhere. Find it and attain it ... Meditate on yourself. Honour your self. Understand yourself. God dwells within you as you." Muktananda further states:

"There are four factors involved in meditation: the object of meditation, which is the inner self; the *mantra*, which is the vibration of the self; *asana*, the posture in which we can sit comfortably for a long time; and the natural *pranayama* which arises when we repeat the *mantra* with love and reverence. These four factors are interrelated and when they come together meditation occurs in a very natural manner."

From all the above it becomes clear that one will have to devote sufficient time to meditation everyday by adopting any of the methods described above. By regular practice with keen desire to overcome all the obstacles in the way, everyone shall be able to achieve the goal of *Samadhi* or Super-consciousness in the years to come depending upon various factors described above.

CHAPTER 13

Biofeedback Methods in Stress

There are feedback systems in all living organisms. But the term biofeedback used here denotes a training in which a person develops voluntary control over various involuntary functions of the body so as to harmonize his body and mind as a whole. Normally various vital functions of the body are carried on spontaneously under the control of the autonomic nervous system and a person has no voluntary control over them. However, with the help of biofeedback training man learns to stabilize his emotional changes and thereby also learns to control the abnormal involuntary functions of various affected organs.

Such training is given with the help of an electronic instrument which would amplify various physiological changes in the body such as blood pressure, heart rate, muscle tension, skin temperature, brain wave pattern etc. These amplified informations of internal changes can be made to trigger over some external signals in the form of light, sound or any other visible recording system. This would enable one to bring the unconscious physiological changes into conscious visible feelings. Thereafter, first by chance, and then by the development of right feeling, a person with the help of this instrument gradually learns how to develop that feeling or will power which would automatically control that particular physiological process. This ultimately produces an awareness of a link between the psychic process and a bodily function. By this method gradually everyone learns to improve the function of his body, initially with the help of an instrument and later even without the aid of any such device.

Clinically it is being used as an adjunct treatment to the well established medical management in cases of migraine, high blood pressure, cardiac arrhythmias, insomnia and many other stressful states. It is also being used along with Yogic practices in many centres to control certain stressful states such as hypertension with gratifying results. Therefore, there is an urgent need for studying the integrated effect of yoga and biofeedback on all the bodily functions in health and various diseases of stress and strain.

Further, there is an urgent need for understanding the methods by which one can produce harmony between mind and body. So far most of the scientific studies were conducted to explore the physical needs of human beings. Rarely studies were conducted to explore the needs and capabilities of our mind. So far behaviour science had been dealing with the effect of external enviornment upon the psychological factors. But now it is possible for a man to verify certain relationship between himself and his internal environment and then interact with it. Thus, with the help of biofeedback systems a person is able to control a wide variety of physiological activities once the information of such disturbed functioning is presented to him in a form that can be perceived by himself with the aid of some instruments. Normally, we can perceive the rate of pulse or respiration by directing our attention to them. But it is not possible to perceive the muscle tone, blood pressure, or brain wave changes in ordinary circumstances. But with these new systems these can be detected and displayed as signals. Thus, we can recognize the nature of these informations, interect with them and eventually learn to control them.

In this procedure the instruments that read the body signals are so modified as to convey information in the form of lights or sounds in relation to normal readings continuously. By this any bodily or psychological change that occurs can be detected at any given time and controlled if needed. In short, these devices will give a person information about his success in acquiring voluntary control over his internal and involuntary bodily functions. By adopting this procedure one can get maxi-

mum information for the medical and psychological fields. This also helps as a therapeutic measure to modulate the abnormal functions such as tension, headaches, high blood pressure, tachycardia, vasospastic disorders etc. In addition to this, this procedure may also help to control emotional changes occurring as a result of stress, which can be relieved by adopting appropriate biofeedback system. Further, it is also interesting that once one learns the technique one can remember and make full use of it for a long time.

This biofeedback system helps to develop an ability of the mind to control all the bodily functions during health and disease. In this way, it integrates the psychosomatic complex through which one can control changes in emotion, reasoning and judgement.

Barbara Brown states: "Biofeedback acts primarily as a temporary intermediary to give you information not ordinarily available to you about the deep within. As with any technique for self-improvement gratifying results can be obtained only with adequate preparation, reasonable persistence in practising the technique, and a modicum of patience. One should not expect results exactly similar to those of someone else." It would entirely depend upon one's own ability to mobilize the physical and mental force to develop a feeling of determination and will power to exercise control over his inner activities.

So far such will power was attainable only through Yoga, Zen and other similar practices. Whereas the results of such practices have been most extra-ordinary in many of the cases, there are no definite parameters to measure such improvements. In biofeedback along with the development of such will power one can simultaneously measure the improvement also. From that point of view, there is an urgent necessity of integrating the techniques of Yoga and biofeedback which may lead to far reaching consequences for improving the bodily and mental faculties.

STUDIES ON BRAIN WAVES

It is known that there is continuous flow of electrical energy from the brain which is recorded in EEG. There are 4 types of

waves, namely alpha, beta, theta and delta waves. By biofeedback method a person not only learns to recognize the type of his brain wave, but also to regulate the output of each one of them. Normally brain cells continuously discharge electrical energy and so far they have not been made use of with biofeedback. One can select one of the waves which may be more beneficial to him such as alpha and try to develop it voluntarily for improving his mental power and memory. Further, the abundance of alpha wave activity has been considered as indicating the state of rest and relaxation. The lack of alpha wave on the other hand indicates a state of anxiety, tension or alertness. It is usually recovered after placing the electrode in the occipital region, in order to study the visual cortex, though it can also be elicited from other regions.

METHOD

In this, patients are allowed to sit on a comfortable chair and two electrodes are applied at the parieto-occipital region on both sides. Thus, electrical waves are amplified and fed through the electronic filter to isolate the range of EEG frequencies that comprise alpha activity. These signals are traced electronically to produce a light at the appearance of each alpha wave or some other indicator. During the experiment the patients are asked to keep their eyes open and try to find out the feeling of their mental state during the appearance of the indicator. Then they are asked to keep the indicator on as long as possible by preserving their mental state in the same position. At the end the amount of alpha activity in the EEG is measured in order to evaluate the ability of the subject to generate and sustain alpha activity. In the first practice one can double and after sittings one can get an increase upto 60% of all the EEG activity. Thereafter, the patients could produce alpha activiy without the help of biofeedback equipment and thus this training enabled them to liberate alpha activity whenever they were in a state of tension.

Kimiya and others used the auditory feedback signal instead of visual and the subjects were rewarded for producing more alpha waves. Such alpha biofeedback experiences are

reported to be quite pleasant and give a feeling of comfortable relaxation. If such a feeling is allowed to continue even after the experiment, it would ultimately lead to relaxation of the mind and the body, and hence it can be recommended for the treatment of anxiety, tension and neurosis.

BIOFEEDBACK AND MEDITATION

Alpha biofeedback has much use in the study of meditation since the subject's feeling during meditation and alpha feedback remains the same. There are several reports to indicate that practitioners of Yoga and Zen develop large quantities of EEG alpha activity immediately after starting meditation practice. Thereafter, as meditation continues, the frequency of alpha wave becomes less followed by development of theta waves. In these practices also an attempt is made to turn the mind and consciousness inwards. Therefore, from the practical point of view meditation and alpha biofeedback appear to be similar and if both could be combined it will have an additive value for getting a quicker result (Fig. 48).

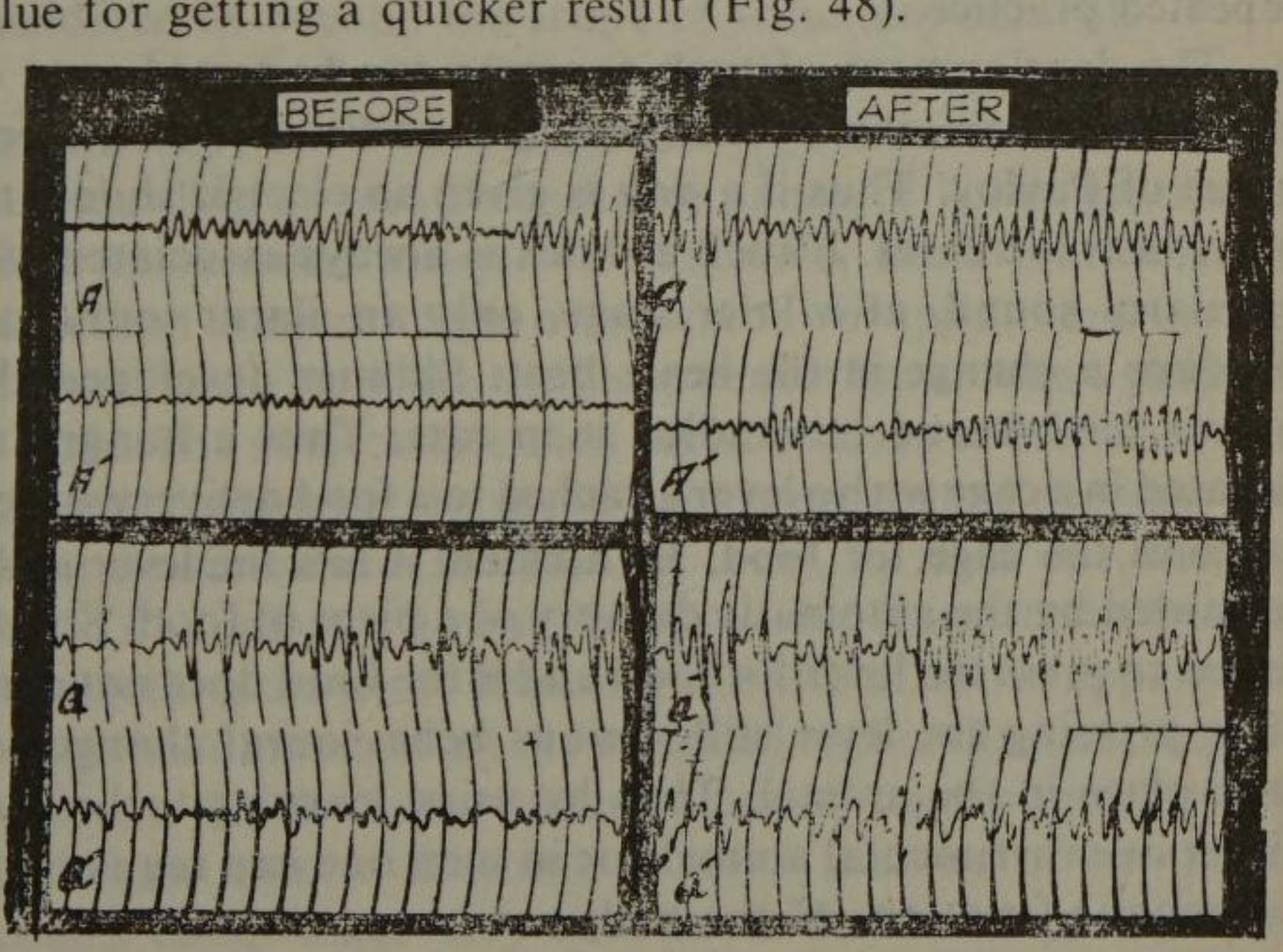


Fig. 48. Shows EEG recordings before and after Biofeedback therapy. Note that before therapy very few alpha waves can be seen. After a regular course of relaxation therapy, a considerable clinical improvement could be noted along with more waves.

CONTROL OF HEART BEATS

It is well known that emotional disturbances are associated with changes in the heart beat. There is a saying "Emotion and mind can relieve illness as well as create them." It is very true so far as the function of heart is concerned. It can suddenly stop beating as a result of sudden severe neurogenic shock, which occurs as a result of increased activity of the vagus nerve. But in all chronic recurrent emotional disturbances with anxiety, anger or fear there is increased sympathetic activity leading to liberation of excess of catecholamines especially adrenaline and noradrenaline. Normally during exercise, infections or emotional excitements the heart rate increases; however if such a state continues for a long time the person develops adaptation and the increase in the heart rate may not continue for a long time. It is well known that the experts in Yogic practice develop an ability to voluntarily control their heart rate. There are proved examples of voluntary control of heart beats by developing a certain type of will power which comes after repeated practice.

The development of such a power can be tested even on experimental animals by following the conditioned reflex technique of Pavlov. Thus if a dog is given an electric shock, the heart beat increases. If such a shock is always associated with an alarm sound, at a later stage, only an alarm sound can produce a change in the heart beat. Skinner developed this power further and he studied it in rats. Thus a hungry rat isolated in a cage with a lever attached to a food delivery system explores the cage for food. By accident it hits the lever and is rewarded by the automatic delivery of a piece of food. Soon it learns to press the lever for food and if the food does not come after pressing the lever still various behavioural changes do take place in the animal. Thus by using learning techniques either in experimental animals or in men one can regulate the autonomic functions of the body.

There are differences between animals and men with regard to response to stimuli and development of conditioned reflex. In men they are greatly influenced by genetic and environmen-

tal factors. In men repeated electric shock to the skin at first increases the heart rate, then it slows down and finally comes back to normal. These changes occur as a result of the adaptation mechanism. Even in this, due to preculiarities of genetic constitution some people respond and adapt quickly whereas others with hyperexcitability respond slowly. Similarly, people with anxiety or emotional disturbances respond more quicky and develop adaptation process more slowly.

Subsequently people started controlling the heart beat with the help of external indicators like a light or a sound. With the aid of external signal one could learn at will to accelerate the heart beat, slow down the heart beat or alternately accelerate and slow it down. This is a very important finding and it proves that heart beat is controlled not only by the autonomic nervous system, but also through mind or psychic centre by repeated practice with the help of an external indicator. This was a great departure since till then autonomic nervous system and the target organs like heart, lungs, stomach, intestine etc. were considered as beyond the scope of voluntary control.

But, with the help of the biofeedback technique, one can regulate heart beat. In this, the subjects are attached to heart rate recording apparatus with two panels of lights, green and red or some other indicators. Whenever heart beat is faster than a limit the green light or indicator will appear, and the red light will be visible when the heart beat is lower than a particular limit. The subjects are then asked to learn to increase their heart rate, whenever the green light is on, and to decrease the heart rate whenever the red light is on, by their own mental effort. Gradually all human beings would learn the technique of controlling the heart beat with the help of above apparatus. It seems that amongst all the organs, heart is the most important organ which comes under voluntary control much more easily than others. In some persons slowing of the heart becomes easier since they have more dominant parasympathetic nerve endings; whereas in others with sympathetic nerve dominance acceleration of heart beat is easier. Such individual variations contribute to the repeated changes of voluntary control.

Here one should also remember that the function of skeletal muscles is dependent mostly on powerful external perceptions, but the autonomic nervous system reacts to external perceptions indirectly through the skin or muscles. That is why voluntary control of these autonomic functions through biofeedback has special significance.

EXPERIMENTAL STUDIES

It is known that Pavlov's conditioned reflex and Skinner's instrumental training are based on rewards, but once the reward is given no learning occurs. However Neal Miller felt that without giving initial reward and without the influence of voluntary muscles if the animals could be trained to control heart rate then one can say that autonomic nervous system can be controlled by the central nervous system. For this study, they paralysed voluntary muscles by curare and gave electric shock to the pleasure areas of the brain to experience some type of reward for their performance. By this process rats not only could increase or decrease heart rates but could also increase or decrease the contraction of smooth muscles of intestine. From these findings, Neal Miller and his associates concluded that the brain, mind or will can be just as effective in relieving psychosomatic illness as it is in causing such illnesses. It was also observed that paralysed rats could control heart beats much better than the controls, indicating that when the muscles are relaxed or paralysed, environmental factors do not affect brain and hence the latter can be better utilized for controlling its autonomic functions. This will have a significance in Yogic meditation. When this is practised muscles usually attain relaxation and during this period they can have better control over heart or other visceral functions. Thus there is a great scope for utilizing this knowledge for the betterment of patients with functional disorders of heart and other organs.

CONTROL OF BLOOD PRESSURE

Stress diseases are increasing at a very fast rate and amongst them high blood pressure is the commonest one.

Amongst all causes psychological stress is the most important and hence one should try to prevent the development of such a disease rather than treat it after the disease has fully developed. Because there are no definite symptoms or warning signs in the initial period of hypertension, it is extemely difficult to diagnose the condition in the early stage. With the help of biofeedback it is now possible not only to cure this disease, but also to prevent it. Muscle relaxation practice is a great additional help in accelerating the process of recovery. Further, with the help of biofeedback we can increase the psychic resistance of a person in such a way that there occurs a minimum of effect of stress on the body systems. Such a resistance can also be developed as a result of regular physical exercise and through meditation. The biofeedback technique for this disease falls in between.

At present most of the patients with hypertension are treated with the help of modern drugs only, especially aiming at the prevention of complications such as stroke, coronary thrombosis or renal failure. Somehow even at present, physicians of repute do not think that psychosomatic stress has anything to do with the development of high blood pressure and hence they prescribe drugs to alleviate physical symptoms and signs. But the main truth lies in the fact that this disease can be prevented if one tries to help the persons control the mind by using combined knowledge of psychological, physiological, biochemical and social factors.

It is known that psychological stress causes release of various neurohumors especially the catecholamines which are liable to constrict the arterioles of the whole body leading to hypertension. However, after repeated stress, the patient may become adapted to such a situation with the resulting disturbance in the liberation of catecholamines as evidenced by the laboratory studies in these patients. Therefore, we have to give an explanation as to how the patient develops hypertension even though catecholamine content of these patients is not very high. One of the explanations is that in these cases the tension in the arteriolar muscles gradually increases after each stress in such a way that later on even a slight elevation of catecholam-

ine may produce vasoconstriction leading to hypertension. However this matter needs further study.

Further, it may be possible that genetically certain individuals might be having a more sensitive vascular system. Hence, any emotional disturbance as a result of stress, may lead to marked vasoconstriction and hypertension. It is also seen that some people develop symptoms even after a slight rise of blood pressure whereas others do not develop any symptom even after a big rise of blood pressure. From these one can say that genetic factors may play some role in developing the sensitiveness of their cardiovascular apparatus. It is also stated by some workers that hypertension is due to the aging process in which elastic fibres of the blood vessels are replaced by fibrous tissue. As a result, the blood vessels become narrowed and thereafter sclerosis sets in. Such a change due to aging process is accelerated if the person is exposed to too much of stress and strain of modern life. However, if the person is exposed to biofeedback, all these changes in the vessels can be prevented or at least delayed for some time.

Amongst various psychological factors, prolonged and repeated anxiety and agitation are associated with hypertension, whereas depression is not associated with such a change. In those cases with emotional distress the sympathetic nervous system becomes hypersensitive and as a result every time emotional changes are associated with increased blood pressure. Later these changes become permanent. All these changes can also be induced in experimental subjects by producing recurring stressful states including disturbing noises. In such states, with the help of biofeedback one may be able to control the sympathetic activity so that the blood pressure does not rise following stress, and the body remains in a state of tranquillity with full relaxation.

Social stress such as unemployment or overwork is associated with hypertension, especially if there is a genetic background. People living in urban areas are more exposed to social stress and hence are more prone to get hypertension than persons living in rural areas. Personality traits may also contribute to a certain extent. Those introverts who suppress their

anger and passion and remain internally agitated for a long time may become hypertensive more often than the extroverts who give an outward expression of their feelings. All introvert personalities, who are liable to get quick emotional disturbances are likely to become hypertensive, and also show signs of aging much earlier. Repeated frustration and insult are the other social events which may contribute to the development of hypertension especially in women. In fact all these persons usually have great driving force, and are always seen striving hard for achievement, competitive, restless, impatient and aggressive. Whatever etiological factors we have discussed for hypertension they will also apply to the patients with coronary artery diseases, since these arteries are also part of general arterial system. That is why, a large percentage of hypertensive cases in later age become patients of angina pectoris and then of coronary thrombosis. From the above etiological factors we can summarize that the main cause for the development of cardiovascular diseases lies in the psychic centre of the cerebral cortex rather than in any other part of the body.

In order to confirm these observations several experimental studies were conducted on rats, dogs and monkeys so as to investigate whether brain can be conditioned to control the functions of the autonomic nervous system. However, none of these findings can be fully confirmed in human cases. Therefore, human beings were exposed to different experimental stressful states with doubtful results. Hence, the only way to study this problem scientifically is to expose the hypertensive patients to different types of stressful situations and also to different types of relaxation and biofeedback methods. Then the utility of the relaxation techniques can be monitored with the technique of biofeedback using changes in skin temperature, muscle tone or brain wave as some of the parameters. Here, one should remember that clinicians give more importance to the diastolic pressure which indicates elasticity of the arterioles whereas psychologists are interested in the rise in systolic blood pressure which indicates spasticity of the vasculature. But the combination of these findings, with the changes in the emotional factors would be a good parameter for the

study of improvement of these patients after using the biofeedback and relaxation procedures. If these patients are studied on the above lines, one can certainly put the management of these patients with non-medical measures on scientific lines.

MUSCULAR TENSION AND RELAXATION

It is known that exercise physiologists are mostly interested in studying the strength and tonicity of skeletal muscles. On the other hand, psychologists would like to study the extent of relaxtion that can take place in these muscles even under tensions and social pressures. With the help of biofeedback and Yoga one can learn to actively relax the muscles which may even affect the states of consciousness and awareness. However, whenever we are in a state of anxiety, the muscle tension increases and the body adapts to that situation and thus tension in the muscles is built up. It is only through biofeedback that we can assess the raised tension and also learn to relax. It was Jacobson, a Harvard physiologist, who studied this problem of progressive relaxation and wrote a book as to how to actively achieve relaxation of muscles of our body. He felt that when the voluntary muscles are under full relaxtion, the involuntary ones also get themselves relaxed. This would further lead to full mental relaxation also, since mental agitation or imagination despite bodily rest invariably increases the muscle tension.

Schultz of Germany then developed autogenous training in which one learns to relax muscles voluntarily by autosuggestion of feeling of heaviness and warmth in each group of muscles. Such a relaxation had immense effect on abnormal functions of the body resulting from excess stress and strain. After relaxation, one proceeds to practise meditation in the form of passive concentration. Such a process of relaxation would ultimately lead to control of the reticular activating system of brain and its function. Because of these possibilities a deep muscular relaxation has many effects including effects on smooth and cardiac muscles, and also various parts of brain especially the reticular activating system.

However, there was no way to find out exactly how much relaxtion has taken place in a given muscle. For this, biofeedback technique is of great value since there will be indicator to show how much relaxation one has achieved and how much further attempt he has to make to achieve the goal of full relaxation. One of the drawbacks of autogenic training or progressive muscular relaxation is that it is a prolonged course and hence it takes a long time to achieve full result. The introduction of biofeedback technique however has standardized the relaxation procedure making all degrees of tension and relaxation specifically identifiable for both the patient and the physician at the same time.

The appartus consists of EMG biofeedback system which is attached to any muscle in the body, such as for tension headache, either frontalis muscle or temporalis muscles are studied. Thereafter, the subjects are asked to relax their muscles by their will power and the progress in the relaxtion is noted. It is seen that such an attempt would cause a moderate amount of relaxtion if there are no biofeedback mointors, and they achieve full relaxation if the indicators are given to him. Here, one should realize that anxiety state cases have a variable degree of muscle tension, which fact was not given much importance so far. It is only now that these tension states can be measured through instruments and appropriate therapies are instituted to overcome them. Usually these patients are in a state of tension and restlessness, and if one gives them relaxation therapy only, they are not encouraged to continue the procedure. However if the biofeed-signals are used, then even a slight gain in relaxation will have a great morale boosting effect and hence the patient will continue to practice this therapeutic procedure which would fully involve his will power and consciousness. As a result, the patient will be so trained in due course that he will carry on his relaxtion procedures at home without the help of any instrument.

BIOFEEDBACK STUDIES OF SKIN

It is surprising that physicians have not realized the fact that the skin can be a very useful mirror of the mind. Therefore,

what we can learn in the biofeedback studies of skin is not to control the skin, but control emotions and mental activity. By these newer techniques it is now possible to assess the ability of skin itself to transmit as well as receive intelligent information and also to monitor the mind's emotion.

It is the electrical activity of the skin that is measured in these cases, which increases in high mental tension and decreases during relaxation. Such an increased activity is associated with excessive sweating in excitement and also with the release of electrolytes, such as sodium and potassium which enhance the skin reactions. Apart from these biochemical changes leading to changes in the electrical activity, there may be other causes of changes in the skin which would result from fear, anxiety, worry, delight and passion.

In order to study this problem we have to attach electrodes to the skin of various parts of the body and connect them to a proper recording instrument with amplifiers. This would record the skin changes which are commonly known as Galvanic skin response (GSR). It is known that GSR differs from person to person depending upon age, sex, race, and culture. It is more active in women than men; more prominent in black races than in whites.

To develop voluntary control over skin reactions one has to strive hard to acquire control over his own mind. Since mental reactions such as conflict, anxiety and tension are so prevalent in our society, it is not easy to develop such a control otherwise than by taking all types of drugs and tranquillizers which have many deleterious effects. Biofeedback is one technique by which we can learn to control the mind through skin reactions. If one can introduce the element of reward for developing a skin response, then one can learn the process much more quickly.

Since skin is also richly supplied by the autonomic nerous system, it would be a very sensitive indicator of emotional changes in the body. Whereas all other internal organs can be studied only through certain instruments, skin changes can be observed much more easily. It appears that emotional changes are closely accompanied by the changes in heart rate, blood

pressure etc. and also the skin changes. Various biochemical studies also indicated that whenever there is an increase of adrenaline and noradrenaline in blood and urine there is a marked increase in the electrical activity of the skin.

It is known that a man learns best when he also has a knowledge of the good result of his learning. The more information he has, the better will be his performance. Since, there are very few methods to get the information about the mind-body relationship and also the possibility of controlling emotions by the body, not much progress has been made in this direction. Further there are also biological variations in the personalities and psychosomatic constitutions of the persons. There are highly neurotic introverts who do not manifest their changes externally nor do they have many changes in the internal organs. Hence, the knowledge of these possibilities should also be kept in mind while studying the skin biofeedback system. By measuring the electrical activity of skin through this system one can gradually learn to relieve the anxiety state. It would be much better if the recording devices are so arranged that both the physician and the patient can watch the indicators of skin responses. This would enable both to agree about the changes occurring as a result of emotional disturbances, and also about reconciliation of these differences between the body and mind leading to tranquillity in the person concerned.

These are some of the biofeedback methods by which one can quickly achieve good results both during health and in a disturbed state.

CHAPTER 14

Kundalini Yoga

There are many types of Yogic practices for the promotion of good health—physical, mental and spiritual. Amongst them Raja Yoga which mainly consists of the practice of yogic postures, breathing exercise, and meditation, is the most popular one. However, those who want to promote their mental health still further should be familiar with yet another important branch of Yoga, namely "*Kundalini Yoga*". It is a part of Tantra Yoga which is being practised by the experts in the field since time immemorial. The main credit for popularizing it in recent years goes to two persons, namely to Sir John Woodroffe (Arthur Avalon) who wrote his well known book *Serpentine Power* and to Shri Gopikrishna of Srinagar who wrote several books based on his personal experience of awakening Kundalini. Recently several studies have been undertaken to find out scientifically the nature of this latent power and the method of its utilization for promoting mental health.

It should be realized here that the practice of yogic postures is mainly directed towards the improvement of the bodily health. However, as a result the psychic power also improves automatically to a considerable extent. On the other hand, the practice of Kundalini Yoga is mainly directed towards the improvement of the nervous system. If people regularly strive hard to improve the functions of the brain, spinal cord and autonomic nervous system it will be greatly helpful in maintaining good health and also improving the level of consciousness. According to Shri Gopikrishna it will be one of the ways by which a person can possibly accelerate evolutionary process of the human species. It is perhaps the only way by which evolutionary changes can be introduced for the betterment of

humanity as a whole in the years to come. Thus he states: "This evolutionary energy is taking man step by step towards higher states of consciousness. In the course of this journey he becomes intellectual, esthetic, talented, a genius and finally an enlightened man". In view of this great potentiality of improving the intellectual activity there is an urgent need for conducting scientific research in this branch of Yoga. If the above claim can be proved beyond any doubt, it can be a great weapon for improving the status of mankind as a whole. Therefore let us examine all the available literature on the subject more closely.

REVIEW OF ANCIENT LITERATURE

The presence of latent energy at certain points of our body was known to our ancients since time immemorial. There are references in our ancient scriptures which are the fountain-heads of our ancient Indian knowledge. There are even indirect references in the Bible and in the Sufi spiritual literature. Suffice it say here that the enlightened people all over the world had conceived the presence of such an occult power in man. Discussing this subject Pandit Gopikrishna states: "The one chief characteristic that distinguishes the Indian systems, especially the thought and practice of Tantra, is the importance given to consciousness. There are several states of consciousness and it is the purpose of yoga to uplift and transform the lower states of consciousness into the higher."

In the *Yoga Vasishtha* it is stated that many supernatural powers can be obtained through stimulating the *Kundalini* power dormantly present at *Muladhara Chakra* which is situated (around inferior hypogastric plexus) in the Perinium. In order to get higher power, it is necessary to arouse this power and direct it towards the brain. There are a large number of ancient books on Yoga, especially on *Tantra Yoga*, which give a detailed description of the method of arousing *Kundalini* or the coiled-up energy. However, it is always better and safer to practice it after getting initiated by a teacher of repute.

By following any one of the methods, if one can arouse the dormant energy at *Muladhara Chakra* into active one and thereafter consciously make it to travel from below upwards in the spinal cord to the brain, it will lead to much favourable results. Thus Narayanananda states: "When by the power of long internal meditation the vast mass of energy stored up travels along the Sushumna (Spinal cord) and strikes the centres, the reaction is tremendous..... It is supersensuous perception. And when it reaches the metropolis of all sensations, the brain, the whole brain as it were, reacts and the result is the full blaze of illumination, the perception of Self..... Thus rousing of the Kundalini is the one and the only way to attain divine wisdom, superconscious perception, realisation of spirit." Here we should remember that attainment of such a power cannot be measured objectively through the eyes or ears. It can be assessed only through the subjective experience of the practitioner. However, here is one of the topics fit for research which can be investigated fully by using all the modern scientific parameters.

ANATOMICAL CONSIDERATIONS

According to *Tantra Yoga*, there are six nerve centres (Chakra) distributed in various parts of the body in addition to the centre in the brain known as *Sahasrara*. There are three *nadis* known as *Ida, Pingala* and *Sushumna* which connect these *Chakras* to the brain. They can be correlated with the spinal cord (*Sushumna*) in the centre with two sympathetic chains on either side (*Ida*—left sympathetic chain, and *Pingala*—the right sympathetic chain). The six *Chakras* can be correlated with the six autonomic plexuses of nerves, namely lower hypogastric plexus for *Muladhara Chakra*, upper hypogastric plexus for *Svadhisthana Chakra*, coeliac plexus for *Manipura Chakra*, cardiopulmonary plexus for *Anahata Chakra,* cervical plexus for *Vishuddha Chakra* and hypothalamo-hypophysical system for *Ajna Chakra*. In Modern Anatomy these plexuses are not given that much importance, though from the point of view of the function of the

organs and viscera, these nerves play an important role in regulating the activities of the whole body. The cerebral cortex or *Sahasrara* influences the function of these vital organs through the autonomic nerve connections. Therefore, experts on *Tantra Yoga* have rightly given so much importance to these *Chakras.*

It is well know that each of these plexuses is fully represented by sympathetic and parasympathetic components. Further, these plexuses send their nerve connections to various organs which act both as sensory and motor nerves. Through these nerves the functions of the organs and viscera are fully regulated on the sensory side. From the plexuses the nerves reach the sympathetic ganglia (*Ida* and *Pingala*) from where the sensations reach the spinal cord (*Sushumna*). Hence there occurs a local reflex action and also a central action after the sensory input reaches the brain. The local reflex arc in the corresponding spinal cord level along with nerve plexuses and the organs concerned can be treated as one *Chakra.* The Tantra experts have enumerated six *Chakras* with *Sahasrara* (cerebral cortex) as the 7th centre of activity.

1. *Muladhara Chakra:* The *Muladhara Chakra* is situated in the perinium with external genitals as the main organs supplied by the nerves from the inferior hypogastric plexus. This is the lowest plexus of the autonomic nervous system with a centre at the spinal cord at the lowest level. Since the external genital organs are richly supplied by both cutaneous (Skin) as well as autonomic nerves, they can be activated through voluntary efforts if one can learn the method of doing so. Perhaps no other organ in the body is so richly supplied by both these groups of nerves and hence this most sensitive part of the body, especially the genitals, has been taken as the sixth sense-organ in *Tantra Yoga* to activate the entire nervous system of the body. Normally all the sense-organs such as eye, ear, nose, tongue and skin carry the sensory messages to the respective areas of the brain via the reticular activating system (RAS) and the thalamus nuclei. Such a message produces a series of changes in the various centres of the brain leading to the

development of the adaptation process in the body by producing changes in neurohumoral and endocrine systems. But according to the concepts of *Kundalini Yoga*, man's brain can also receive powerful stimuli through the external genitalia, via the spinal cord and thalamus. Although the resulting sensation is a sort of skin sensation, it has been given a special significance and therefore a separate status. Thus if one can save the sexual energy through the practice of *Brahmacharya* (abstinence from sexual activity) the same can be utilised for the stimulation of various areas of the brain such as the psychic centre for obtaining more productive and useful results. In fact the possibility of voluntary stimulation of *Muladhara Chakra* situated in the Perinium close to the region of external genital organs leading to voluntary stimulation of certain specific areas of the brain is one of the most important contributions of *Kundalini Yoga*. It is through this route that the ancient sages obstained remarkably useful results by activating the brain for the betterment of the people in general. However, becaue of the fact that the matter had been kept relatively secret, the common man could not derive the fullest benefit from it and only a few selected disciples of some renowned sages could make full use of this knowledge.

Now the time has come to study the phenomenon scientifically so that humanity at large may be in a position to derive maximum benefit from it. Gopikrishna also states that the awakening of Kundalini can be useful for the improvement of the level of consciousness of future generations. Obviously the *Muladhara Chakra* situated in the region of the external genitals and supplied mainly by inferior hypogastric plexus of nerves plays a very vital role in the initiation of sensation which passes through the sympathetic chains to the spinal cord so as to reach ultimately the brain to produce a series of changes. The *Muladhara Chakra* has a special significance in that it may also stimulate the remaining five *Chakras* before the stimulation from it reaches the *Sahasrara Chakra* situated in the brain. However, all these statements of Tantric Yoga need scientific confirmation. We will revert to this subject once again at a later

stage. Suffice it to say here that it is the *Muladhara Chakra* which is a starting point for all the newer sensations. It is at this level that a further scientific study will have to be initiated to find out the truth of *Kundalini Yoga.*

Svadhishthana Chakra

This *Chakra* represents uppęr hypogastric plexus which supplies sympathetic and parasympathetic nerves to the bladder, rectum, prostate, and seminal vesicles in males, and bladder, rectum, uterus, and vagina in females. The sympathetic nerve connections are from the sympathetic chains which are connected with the spinal cord at the appropriate level. The parasympathetic nerves come from the Nervi Erigense from the spinal cord. This *Svadhishthana Chakra* consists of the spinal cord at the level of the two connections mentioned above,the connecting nerves to the plexus, upper hypogastric plexus itself and the organs supplied by this plexus of nerves. A clear knowledge of these anatomical connections is essential for a person interested in meditation so that he can concentrate on all these structures while fixing his mind on *Svadhishthana Chakra.*

Manipura Chakra

This is one of the important *Chakras* and has many nerve connections with the visceral organs. It represents "coeliac plexus" of nerves with vagus as parasympathetic nerve component and greater and lesser splachnic nerves as sympathetic nerve connections. The spinal cord connections would be almost at the same level as that of coeliac ganglion. The organs that are supplied by this ganglion are the whole of the gastrointestinal canal (except the lower part of the large bowel), liver, gall bladder, biliary tract, pancreas, spleen, kidney, ureters and suprarenal glands. In view of the fact that this *Chakra* regulates the function of most of the abdominal viscera engaged in digestion, absorption, assimilation and excretion, metabolically it has a very vital role to play. Thus those people, who

have some digestive or metabolic disturbances will have to take greater interest in this *Chakra* to regulate the activities of these organs.

Anahata Chakra

Anahata Chakra is the fourth centre in the body consisting of cardiopulmonary plexus present in the chest cavity. It is also supplied by vagus nerves from the parasympathetic side and cardiac and pulmonary branches of nerves from the sympathetic chain. This plexus of nerves not only supplies the heart, lung and trachobronchial tree, but also the oesophagus, aorta and other structures of the chest cavity.

Vishuddha Chakra

The *Vishuddha Chakra* is situated in the region of throat consisting of oropharynx and larynx. The parasympathetic nerve connections come from the respective cranial nerves (3, 7, 9, & 10th nerves) and the sympathetic nerve connections come from the cervical sympathetic chains. They supply nerves not only to the eyes, ears, nose, pharynx, larynx, and trachea, but also to mouth, the salivary glands, and thyroid and parathyroid glands.

Ajna Chakra

The sixth centre is the *Ajna Chakra.* It is located in the hypothalamus, limbic system and the neighbouring region with the connection of pituitary gland on the lower and front side and pineal gland on the upper and back side. It is known that this is the main area where there are centres for regulating the functions of the entire autonomic nervous system consisting of both sympathetic and parasympathetic nervous systems and also the centres of hunger, thirst, sex, emotions etc. Therefore, *Ajna Chakra* is considered as an important one for regulating all the functions of the above-stated five *Chakras.* The traditional Tantrikas state that this is the main seat of mind and it is from here that a person regulates his basic bodily needs.

Sahasrara Chakra

This *Chakra* comprises the whole of the cerebral cortex. This is the main area controlling the various levels of consciousness, such as the conscious, sub-conscious and superconscious states. Here the entire *Kundalini* energy starting from *Muladhara Chakra* upto the *Ajna Chakra* merges at the *Sahasrara* level (psychic centre of cerebral cortex) to produce its desired results in an awakened state. Thus the mind, intellect and all the levels of consciousness merge together to make him an enlightened person. Therefore this is the most important centre where the *Kundalini Shakti* culminates from below upwards and produces its desired results all over the body from above downwards. That is why while preactising *Kundalini Yoga* one concentrates on these *Chakras* from below upwards at first and then from above downwards. The result is that there is a free communication between all the seven *Chakras* and also with the various organs and regions supplied by these *Chakras*. Thus the level of consciousness remains very high not only with regard to the perception of the external world but also with regard to the awareness of all the internal organs and tissues. This is perhaps the most important yet most inexpensive technique by which one can dive deep into one's own level of consciousness and thereby into the various internal organs and tissues. One should know the full technique of *Kundalini Yoga* as described by the ancient sages

Practice of Kundalini Yoga

Here one should remember that if one wants to become successful in his practice of *Kundalini Yoga*, one must regularly do the *Hathayoga* exercises also (See Chapters 10 & 11). One should be especially conversant with *yama, niyama, asana* and *pranayama*, so that one can prepare one's body and mind well for the practice of *Kundalini Yoga*. The practices of *yama* (good social interactions) and *niyama* (good personal behaviour) are some of the aspects of life style to be followed by each and every aspirant. Through these methods, one tries to res-

train one's sensitive senseorgans and turbulent mind. Normally there is a tendency on the part of mind to externalize its connections through different sense-organs. Our attempt should be to restrain these tendencies and then to internalize them so that we conserve and utilize all our energies for the better purposes of our life.

Brahmacharya or celibacy is the most important of *yamas*, which has to be practiced as best as one can if one wants to awaken the *Kundalini Shakti* in the near future. If one does not regulate one's sexual behaviour to its utmost, one will never be able to achieve the goal. By too much of sexual indulgence one loses not only the bodily energy, but also that of the mind. Discussing the problem, Swami Narayanananda states, "Not only the sex-organ is to be controlled, but also all the other senses. One constantly loses so much of energy and vitality by the unnecessary activities of various senses. Austerity teaches one to control and conserve this great wastage of energy through the various sense organs and mind..... He who cherishes, desires, he who hankers after sense-objects is always restless and miserable. A man of craving will have no peace of mind. A restless man is always weak. And he who is indifferent to the cravings of the senses, and he who keeps the mind and senses under restraint lives in great peace and power. This great internal strength, the gigantic will power, and the one-pointedness of the mind one can have by intense *Tapasya* .... By intense *Tapasya* one gains not only the purity of mind, nadis and the body, but also gains strength through which one can easily take Kundalini Shakti to higher planes." From this one can easily understand how important it is to conserve energy, especially sexual energy as best as one can if one wants to awaken *Kundalini Shakti*. It does not mean that there should be total abstinence from the sexual act for a young man. It only means that a strictly regulated sex will greatly help one to awaken the *Kundalini* at faster rate than one who indiscriminately misuses this energy for bodily enjoyment.

As for the *asanas* one has to practise at least eight to ten *asanas* everyday in order to get one's body fully prepared for

the awakening. The choice of *asanas* can be variable depending upon the age and sex of the individual. Young persons should practise more strenuous types of *asanas* whereas older people should resort to the milder types. However the total time taken for this purpose should not be more than 15 to 20 minutes. One should maintain proper balance between the time allotted for physical postures and that for the other integrated Yogic activities.

Pranayama: Literally *pranayama* means controlled intake and output of air through regulated breathing. But in actual practice it has a deeper meaning. It actually means the control of the cellular metabolism of the entire body as a result of regulated supply of oxygenated blood to various organs and tissues leading to the optimum release of energy for performing various bodily and mental functions. In the ordinary sense *prana* can be equated with breath but in a deeper sense it can also be taken as energy liberated in the body at the level of each cell. Hence breathing in and out is the visible gross meaning of *pranayama*, whereas cellular respiration leading to liberation and utilisation of energy in the organs is the real meaning of the word. However, both are but intimately related, because if the visible breathing stops for more than five minutes, there is an irreversible change in the cells of the brain leading to death of a person. Similarly if the breathing is there but the cells of various organs do not get the oxygenated blood due to failure of the heart, then also the person dies due to lack of oxygen. Therefore, *pranayama* is the most important exercise which has a far reaching effect on the liberation and utilisation of the vital energy throughout the body. The whole nervous system, especially the brain is the most sensitive organ for effecting an increase or decrease in the oxygen supply. However, if a good *Pranayama* exercise is carried out according to the standard traditional technique, it will activate the entire brain, spinal cord and the autonomic nervous system in such a way that these become fully prepared to participate actively in the further developments of the *Kundalini Yoga.*

The actual technique of performing *pranayama* has already been discussed elsewhere. However, as a preparatory procedure for awakening *Kundalini* one should practice *pranayama* more vigorously at least 4 times a day, i.e. in the morning, after-noon, evening and at night. One should always sit comfortably on the floor or on a hard wooden seat. The environment should be good, peaceful and without much distraction. *Pranayama* should always be performed on empty stomach, at least three hours after taking food or drink, and not when one is tired or agitated. It should be practised as far as possible in a fixed place with a pleasant and clean environment. At first, after taking a deep expiration one closes one nostril with middle finger, then one takes a deep inspiration for 4 seconds, holds it for 16 seconds and expires the air in 8 seconds. Following this ratio, he repeats the performance through the other nostril, by closing the first one by the thumb. In this manner one carries on beathing exercises, 20 times, slowly and steadily. This gives the practitioner a feeling of lightness of the whole body and also a feeling of warmth in the surface of skin indicating an improved circulation with fully oxygenated blood throughout the body. Later on when one becomes more experienced one can double the ratio from 4 seconds to 8 seconds for inspiration, 32 seconds for holding and 16 seconds for expiration. However, such a change should be done very carefully and gradually. Otherwise it may put a severe strain on the heart and lungs of the practitioner leading to very harmful effects. Therefore, one should make such a change only when one's health permits to do so without the slightest evidence of any discomfort. *pranayama* should be carried out regularly throughout the year. By this process one can always see that the nervous system which is highly sensitive to the oxygen intake becomes always alert and therefore it becomes easier for the practitioners of *Kundalini Yoga* to achieve the goal of its awakening at a much faster rate than otherwise. However, a regular practice of *pranayama* is the integral part of *Kundalini Yoga* and therefore it should be treated as part and parcel of the same procedure.

Practice of Kundalini Awakening

There are many methods of this though comparatively much less has been written about the actual practice of awakening the *Kundalini*. This is perhaps due to the fact that it is dangerous to start the practice of *Kundalini* awakening without personal supervision of a Guru or Teacher. It is surprising that so much has been written about the effects of an awakened *Kundalini* and yet so little has been written about the actual technique. We have been able to get the method from quite a few sources since it is unfortunately kept as a secret art by many of the Tantrika experts.

The technique of *Kundalini Yoga* which can be practised without much difficulty is the one we are going to give below. There can be many variations and we would like to describe one of the variants in some detail. Whatever may be the technique one adopts, one should stick to it throughout till one achieves the goal.

The Technique: In this the practitioner sits in a comfortable posture (*Sukhasana*) or lotus posture (*Padmasana*) on a seat of folded blanket or cushion. At first he performs *pranayama* 20 times according to the method already discussed. Thereafter he closes his eyes and fixes his mind internally on the different *Chakras* one by one from below upwards for a minute. At first he fixes his mind on the *Muladhara Chakra* for a minute from the lowermost part of the spine to the genitals. In each *Chakra,* one creates fine vibrations by contracting the underlying muscles along with taking deep respirations (*Pranayama*). These vibrations are produced not only in the area of the skin but also in the organs supplied by the respective plexuses of nerves. Therefore, the anatomical knowledge of these plexuses of nerves and the organs supplied by them is essential for proper understanding. Thus in each *Chakra* the practitioner fixes and concentrates his mind consciously and produces fine vibrations in the region including the organs supplied by the *Chakra*. This naturally leads to better blood supply, more utilization of oxygen and more liberation of energy for better functioning of the organs and tissues of the region. After

Muladhara Chakra he takes his mind in the same way around and inside the *Svadhishthana Chakra* in the lowermost part of the abdomen for another minute. Then he takes his mind and allows it to concentrate on the upper part of the abdomen above the umbilicus (*Manipura Chakra*) where most of the abdominal viscera are situated. Then he takes his mind further up in the chest for concentrating on the heart and lungs (*Anahata Chakra*) for the next one minute. Then he takes the mind upwards and fixes it for a minute on the *Vishuddha Chakra* in the throat including larynx and trachea. This should be followed by the fixing up of attention on the lower part of the brain(*Ajna Chakra*) for a minute. Finally the practitioner fixer up his attention on the cerebral cortex for three minutes. Immediately after this *pranayama* should be performed and repeated 10 times followed by concentration on various *Chakras* in the reverse order and *pranayama* again repeated 10 times. Day by day with the progress of concentration of the mind on these *Chakras* he experiences an ever increasing feeling of well-being and ultimately becomes a person of greater enlighenment than others. He becomes more sober and calm and becomes less irritated when he faces any stressful situation. This is one of the methods of achieving the goal of *Kundalini* awakening, and should normally be practised over a period of many years.

POWER OF *Kundalini*

So far we discussed the technique of awakening the *Kundalini Shakti* so that we can make use of the energy so liberated for the betterment of all. Here it should be remembered that the aspirant should not allow the energy liberated by the awakening of *Kundalini* to he misused for his selfish ends. In fact the power liberated by his own efforts should be fully utilized for the service of humanity. Let us see how and in what way one can serve the people through the liberated *Kundalini Shakti*.

Psychological factors and Sopontaneous Awakening

As already stated, the world is moving at a fast speed due to rapid advancement in Science and Technology. Because of

this, most of the human beings are unable to adjust to the newer type of society and culture. The most sensitive organ which has to make adjustment in our body is the brain, especially its psychic centre. It is well known that normally people make use of only 10% of the psychic centre of the brain, and the remaining 90% which is generally known as the "silent area" is not used at all by the majority of people. If by any means we can make use of this area by supplying more energy by awakening the *Kundalini*, it would be one of the easiest way by which a common man can enlighten himself with comparatively much less effort and with no extra expenditure on the part of anyone.

Now the question arises whether the functioning capacity of the human brain can be improved or it is only a wishful thinking. It is known that the use of certain psychotropic drugs such as amphetamines, canabis or its derivatives can produce certain psychological benefits in this direction. However, it is also known that they are quick in habit forming and hence cannot be used for a long period.

The other method by which one can improve the functioning of the brain is the practice of some type of Yoga, especially the *Kundalini Yoga*. Usually the brain does undergo some change for the better in the normal course of evolution. But to wait till such a time will be too late. In order to expedite such a process of evolution one will have to quicken the pace of transformation in the psychic centre of the brain. This will also enable the brain to adapt itself at much faster rate to the vast changes that are taking place so rapidly in the modern time. So far the only technique which can help to increase the power of the Psychic Centre of the brain to meet the challenges of the modern age, is that of Yoga, especially the Kundalini Yoga. Discussing this topic, Rohit Mehta says, "It is the prerogative of man to expedite the evolutionary process. It is within the power of man to initiate new evolutionary movement. Conscious evolution is within the power of man. And conscious evolution must imply a fundamental transformation both of the mind and brain. This is the part of the process of Real Yoga... Since brain is the important link in the chain of con-

scious evolution, it may be asked pertinently: Can the range and quality of brain be changed? If so how?" In the human brain, there are two major parts, the lower or animal part, namely the hypothalamus and limbic system and the second neocortex or the cerebral cortex. Normally in an average person the animal brain is very strong with all the centres of emotion, pain, hunger and sex. Because of this strong basic and evolutionary fact one is always busy in keeping these lower brain centres active and we hardly get much time to improve the functioning of the cerebral cortex, especially its psychic centre. Thus Mehta says. "The cortex or the upper brain is engaged mostly in intellectual growth, but this intellectual development has no chance to survive due to pressure of instincts coming from the lower or animal brain. We cannot rule out the animal heredity, what we must be concerned about is to see that two parts work harmoniously so that animal energy is canalised into finer channels supplied to the upper brain....." To increase the brain potential to activize the large unused areas of the brain—this has become the urgent need of man if he is to travel successfully into the new land of Yoga. How is he then to initiate the necessary steps for transforming the brain so that it is able to work at its full potential. This can be done by many ways. One of the methods by which one can improve the working of the brain is by providing greater amount of oxygen to it. This can be done by *pranayama,* the technique of which we have already discussed. Thus by supplying oxygen we can liberate more energy in the brain by which it can renew its strength for doing more vigorous work. Another method of improving the power of the brain is to practise the relaxation posture or *shavasana,* which also helps to regain the normal psychological power of the brain by getting over tiredness and tension in life. Thus by the repeated performance of *pranayama* and *shavasana* as and when required, it would be possible to regain the strength of the brain and also to increase its activities to the optimum level.

In view of their many deleterious actions and habit forming tendency one should for this purpose never resort to the intake

of drugs such as tranquilisers or other psychotropic drugs. Fruther these drugs instead of giving relief from tension many times produce mental depression if used for a long period. In addition, once the effect of drug goes out, there is heightening of susceptibility to tension, stress and strain in life. In view of all these risks the intake of drugs should be always avoided except when there are emergency situations. In all other situations we should resort to yogic practices as far as possible, especially *shavasana* and *pranayama* to get over the tension and tiredness of the brain.

For improving the function of the brain for a prolonged period mere *pranayama* will not be enough. For this purpose continuous supply of biological energy is needed. For this one will have to resort to *Kundalini* type of yogic practices everyday. It may be noted that *Tantrika* Yogis attached great mystery around the awakening of *Kundalini* and have guarded this Yoga with great secrecy.

However, it should be remembered here that for any improvement in the activity of the brain there is a need for the supply of biological energy continuously. Otherwise, no matter what we do, it will not produce any significant change in the brain. As already stated only 10% of the brain is functioning at the psychic centre level. If the unused 90% of the brain is to be brought into action, it must be supplied continuously with abundance of fresh energy throughout the period. Discussing this matter in great detail Rohit Mehta states, "It is with this energy that the needs of centres of learning can be brought into existence in unused areas of the brain. Without establishing such new reverberating centres, the brain cannot function effectively in an age when changes are taking place at a phenomenally rapid place. The old brain can ill-serve the needs of the present age. And if man cannot adapt himself quickly to fast moving conditions of life, he faces great hazard in the sphere of his survival. Faced with this situation Kundalini seems to be the only answer."

However, the methods that have been described by *Tantrika* experts or by the experts of *Hatha Yoga* are too

difficult to be practised by the common man. In fact the ordinary man will be frightened if he is asked to practise all these complicated methods. He will not have enough time to learn and practice in his everyday life. Further there are not enough teachers to teach these techniques to the common man in need of it. In addition, if these forcible methods of awakening *Kundalini* are not followed strictly in accordance with the instructions, they may lead to many complications causing physical or mental ill health. Therefore, one will have to search and adopt some easy methods for the use of common man.

Here one should follow the advice of Sri Aurobindo who speaks of spontaneous awakening of *Kundalini* as against the *Tantrika* methods already described. The spontaneous awakening of *Kundalini* is a method by which a person by his own efforts and without depending upon the help of anybody else can awaken *Kundalini*. Because of this it is bound to be free from hazards and dangers. Rohit Mehta explains this simple method of awakening *Kundalini* as the fusion method. Thus fusion takes place at the *Sahasrara Chakra* in the brain by joining the feminine or negatively charged *Shakti* with masculine or positively charged element in the head. When both of them fuse together there is a liberation of biological or cosmic energy which ultimately gives additional strength to the newer areas of the brain causing newer enlightenment. It is known that the nuclear energy can be liberated either by the conventional method of fission or by the newer technique of fusion. In the same way here also Mehta suggests the fusion way of liberating biological energy by joining *Shakti* and *Shiva* in a spontaneous manner. Mehta states, "In the awakening of Kundalini what takes place is the release of biological energy. This happens because of the negative and positive poles of our biological mechanism being induced to come together. The Muladhara Chakra is where Kundalini power lies coiled. If it is stimulated then the positive pole which is Sahasrara will experience a union with the negative pole. It is when this happens that energy is available to the body, for the entire biological entity. This release is experienced in the brain and so the brain

is endowed with a great deal of released energy with which it brings the unused portions into operation." It is known that whenever we are happy we feel more energetic and active. It seems that at that time we receive some additional energy from some source. On the other hand, when we are disturbed or when we are in pain our energy becomes much reduced and our creativeness narrows down considerably. It is, therefore, logical to think that during the feeling of happiness the additional energy that we get to our brain comes from nowhere else, but from *Kundalini*. However, if we misuse such an energy, which has been liberated during the state of our happiness we would be losing great opportunity to improve ourselves both physically and mentally. On the other hand, if we can explore further and receive an abundance of energy through making ourselves happy which leads to the spontaneous awakening of *Kundalini*, then we should be able to bring the unused portion of the brain into fullness of activity. Such a spontaneous release of energy for the use of the brain as a consequence of the feeling of happiness will lead to many creative activities, which will also be a natural way of improving the evolutionary process.

What are the signs and symptoms in a person who has really awakened *Kundalini* in the spontaneous manner? This has been nicely described by Rohit Mehta in the following manner: "Such a man has quick adaptability to outer challenges due to the activation of wider areas of the brain. There is a maturity in such an individual, for he is no longer the creature of the herd. There is an effluence in his body vitalised as it is by the flow of new energy. He has a wider and wider contact with life and is able to move about in a variety of fields, subtle and intangible, so far as life's experiences are concerned. His powers of communication are greatly intensified so that he is able to communicate with others with clarity and simplicity. Such an individual has tremendous power of absorption so that his brain is ready to receive sense impacts as they arrive from all the sense-organs. Thus such a man is able to live a fuller life in a universe that is much wider than what we know." In fact he is the person who distinguishes himself from all others in every

field of activity. His great creativeness and notable performance should make us feel that he has abundant source of biological energy which enables him to perform his activities so well. Here one should remember that such a person should not store and utilize energy only at the brain level. He should gradually bring down step by step his energy resources. The biological energy so liberated spontaneously as a result of feeling of happiness should be utilized not only by the brain, but also by the whole body so that there is a full development of entire psychosomatic apparatus to meet the newer challenges of life. Thus there is at first a spontaneous ascent of *Kundalini* from *Muladhara* to the *Sahasrara* followed by a gradual descent through the six *Chakras* nourishing each one of them on the way. Such an ascent and descent of Kundalini becomes a rhythm which maintains the health of the individual, especially of the most sensitive part of his body, namely the nervous system.

It is a mistaken idea that once one awakens his *Kundalini* power one can sit back and relax during the rest of one's life. In fact it is a continuous process and one will have to practice it all the time if one wants to maintain oneself much above the general masses of people. Therefore, once one learns the technique it will be his life-long companion for the practice throughout his life so that he can maintain his highest position both at the physical and mental levels. Though all the human beings appear to be alike it is the activity of the brain which differentiates one from the other. Those who care for improving the brain activity through any one of the techniques described above will be able to meet all challenges of life boldly and efficiently.

If a man has to survive biologically and psychologically, the development of such an efficient brain and the emergence of the new mind are absolutely essential. It should be remembered here that the increased source of energy supply to the brain alone does not solve the problems of the society. A man has to rearrange his living with the entire environment in such a way that he can live congenially and happily without much conflict with society.

PHYSIOLOGICAL ASPECTS

It is now well known that one of the main activities of the brain as a whole is the continuous development and maintenance of consciousness. Consciousness can be defined as an expression of total activity of the brain with regard to its environment. On the other hand, mind can be defined as the sum total of brain activity. Amongst various activities of the mind, consciousness, memory, learning and creativity are some of the important ones which differentiate man from the rest of the animals. In this respect man is unique since he possesses the capacity to learn and be modified by experience as a result of modification in the biochemical components, cellular structure and electrical response of the brain. Here one should remember that a profound environmental or behavioural change is usually represented by a very small change in the components of the nerve cells of the brain. In fact, quite wide differences in behaviour, intellectual capacity, and social and moral status are observed in the brain corresponding to a small physicochemical or structural difference. Thus the minimal structural or biochemical changes in the brain as a result of genetical or environmental factors may produce vast changes in the behavioural pattern of human beings.

We have no control or hold on the genetical factors inherited by each individual at the time of birth. We can, therefore, influence only the various environmental factors from the very moment of conception and especially after birth as the baby comes in the world.

Nutritional Factors

One of the important environmental factors which influence the growth and development of the brain in infancy is food. It has been shown in experimental animals that if they are malnourished or undernourished for some period following birth when the brain has to grow rapidly, the growth of the brain becomes retarded. However, if the adult animals are put on starvation diet, the body weight sharply declines,

though the brain weight remains relatively constant. This occurs as a result of the defence mechanism of the body to protect the brain, which is treated as the most vital organ. Thus it is stated that the body sacrifices almost every other organ of the body in order to give protection to the brain. According to John Dobbing's work, once the brain growth has become stunted in the early period, it can never catch up with the brain of the normal animal, even though the same has been fed with as much food as it can eat. Thus during growth, there are certain sensitive periods when the brain growth may become permanently impaired. What is surprising is that such an effect lasts as long as the individual lives, no matter what happens in the subsequent period. Although all these scientific observations are made in rats, one can certainly draw inferences from these studies for understanding the growth of the human brain also.

In the rapidly developing world today mal-nourishment to the point of starvation occurs on a massive scale in most of the developing countries. Amongst all, protein deficiency and protein-calory malnutrition are the most serious and widespread problems in the whole of the developing world. Such a situation is partly due to low socio-economic status of these countries and partly due to ignorance. If such a situation is allowed to continue, a large number of children will be having chronic protein deficiency leading to the development of Kwashiorkor. In this condition, the brain is markedly retarded and then learning capacity becomes very low. Such a situation cannot be improved for a considerable period of time since improvement in the nutritional status of these children will not change as a result of poverty. As a result the poor psychological and intelligence status of present day children also will not change.

It seems that in the world today 7 out of 10 children or, in other words, about 350 million children under the age of six are in the risk of protein malnutrition leading to distorted development of certain areas of the brain resulting in massive psychological problems in a large percentage of cases. How in such

maladjusted children can we improve the mental status? It is indeed a stupendous task. Can the practice of Yoga, especially *Kundalini Yoga*, restore their abnormal behaviour and subnormal intelligence to normalcy? This is the main task before the scientists of developing countries. It is high time that they investigate and evolve suitable yogic methods for achieving a psychological uplift of their people.

Discussing this subjet at length Steven Rose states, "One may estimate the sensitive period in human development, during which undernutrition is likely to have an effect on subsequent brain development and which may last from birth to eighteen postnatal months. Over the next five or six years of childhood, if malnourishment over a prolonged period occurs, this too may be expected to produce effects on subsequent brain development and performance although perhaps less severe ones. These studies suggest too that the nutritional state of mother during pregnancy can also have a long lasting effect on brain and body size." It is now well known that low IQ scores are associated with low socio-economic background of parents, large family size, and poor state of health of the mother during pregnancy. It will possibly take decades, if not centuries, before one can ever expect to get a correction of all these psychosocial factors, especially the low socio-economic condition in developing countries. It means that the brain and psychological status of these people living in developing countries will gradually deteriorate to such a state that they can never be compared to the brains of developed countries unless they migrate to those countries at their early age. Is there any quicker solution which would have a lasting effect on all the people so that all the brains living in the developing countries can be equated with those of the developed countries in the psychological level, if not in the physical level. How much this time-honoured Yoga can help to bring about a change for the betterment of the brain in the face of the gross nutritional disturbances? We need to study this problem in order to answer this important question.

Environmental Factors

It is known that animals which are kept in isolation have less amount of neurohumoral enzymes and thinner cerebral cortex than those which are kept together along with other animals of the same age group. Those animals which have received enough sensory stimulation of light or sound in the early age have better developed sensory cortex than those which are kept in a state of sensory deprivation. Therefore, those people who are exposed to some type of stress are more able to cope with the situations than those who grow up in complete isolation. Not only there are behavioural differences between the two groups of animals, but one can observe anatomical and biochemical changes also. In similar experiments on monkeys, the same scientists have shown that breeding them in isolation results in an apparently permanent incapacity to form normal social, sexual, or parental relationships in later life. Similarly it has been seen that those students who studied in purely unisexual colleges, especially the girls' institutions, fare comparatively poorly in their life especially with regard to their social and marital relationships than those who studied in co-educational institutions. The scientists have also observed that if a female monkey had herself been reared in isolation then she was unable to make a normal maternal relationship with her baby. This does not mean that one should permit too much of overcrowding in a large family. This has its own drawbacks such as poor housing, incomplete education and sometimes even sensory deprivation. Thus the extremes on either side are not good for the proper growth of the brain and its optimal behavioural responses.

Here one should remember that in the early period of life one should neither be exposed to too much of environmental stress nor complete deprivation, as both result in poor development of brain and endocrine systems including the adrenal gland. However, in the developing countries, the child does not have much choice and he has to face too much of odds. How can one develop a capacity to triumph in spite of the adversity and to succeed in life in spite of many odds. This needs to be

studied, especially in the people living in trying conditions in the developing countries. Can the introduction of some type of Yoga make them more efficient to face the challenging situations in their life. The introduction of such a Yoga will not cost them much in their life, yet they can derive the fullest benefit for facing all the stressful situations in society. It is really surprising that the human brain has a tremendous amount of plasticity and therefore there is no reason why such an experiment will not succeed in the near future.

Genetic Factors

It is always difficult to make out in a given person how much of his mental qualities, such as intelligence, is genetically determined and how much the environmental factors have contributed to it. It is important however to assess it, because it is known that the genetic factors cannot be changed, but one can change the environment for an ideal set up so that the brain can grow to its maximum capacity. It has been realized for a long time that certain individuals are genetically superior to others so that nothing can be done environmentally to effect improvement in their brain power. Certain Western scientists maintained that genius is hereditary and advocated a policy of selective breeding to maintain a selective stock. Recently some geneticists have collected semen of a large number of Noble Laureates for conducting experiments to assess exactly how much genetic factors contribute to the development of intelligence. However, it would take generations before anything can be said about it with reasonable amount of certainty. Certain psychologists, especially of UK, have made the following observations in this regard. "Intelligence is largely inherited. The middle class is more intelligent than the working class. The working class has more children than the middle class. The national intelligence is therefore declining." In the same way in USA a hypothesis has been put forward that the IQ of the Negro people is lower than that of the white population. However, these observations seem politically motivated and so cannot be accepted in any democratic country. Further it has

also been proved that intelligence cannot be assessed by the current methods alone. One cannot also always make a very sharp division between the genetic and environmental factors because it is the environmental changes which start influencing the genetic ones in a given person such as malnutrition, sensory deprivation etc. After certain generations the same phenomenon may be found as a genetic trait. Hence it will be difficult to make a specific statement in this regard and therefore various health promoting measures for the brain, such as *Kundalini Yoga,* which can certainly influence the function of the brain should be tried in all persons. This would certainly lead to the promotion of health, especially in people living in the developing countries where the health of the people is always in jeopardy due to a variety of causes.

Memory

One of the most important and vital characteristics of the brain is that it has a capacity to become a storehouse of memories. We begin to lose such memories after injury, illness or in old age. These memories are the stored records of expe-riences of an individual and this is the highest and most important function of our brain. There are a number of mechanisms involved in the memory process. At first there is learning. Subsequently a second event may occur in which the memory is brought out of store to be compared with some current event, which is called remembering. In addition to this, there can be a third process which occurs if an event cannot be recalled and which is called forgetting. It is now known that memories are extremely difficult to trace once they are established. We all retain memories of events which occurred years ago. Thus, like a scar tissue in the body, memories in the brain are the most durable environmentally imposed individual characteristics. Memory cannot be compared with the electrical activity of the brain, since these activities can be changed or reduced to the minimum by using drugs etc. But the memory of an individual cannot be abolished. Therefore, there must be some permanent impression in the brain which would have some anatomical or

biochemical basis. In the earlier period some workers had put forward the theory of thickening of synaptic cleft where the memories have been stored. However, this has not been accepted by the majority of scientists.

Recently it has been proposed that there are two types of memory, long-and short-term. At first all the memories are short-term. However, those which can be retained for some time, say half an hour, are converted into long-term memories. It is stated that short-term memories are stored in the hippocampus and the long-term memories are stored in the association areas of the cerebral cortex. It has been extensively found in chicks that whenever learning taken place, the RNA and its polymerase increases in the centre of the cerebral cortex involved in the process. It was even found out that the more birds learnt the more RNA is seen. The more RNA the birds made the more they learnt. In the learning process RNA is synthesized in the cell which acts as a Template for the production of new protein in the cell body. Perhaps the proteins produced during the learning process travel down the axon to the synapse. Thus it produces a permanent change in the synaptic efficacy. Anatomically one can visualise change in the synpatic cleft and biochemically one can observe the increase in the RNA and its polymerases during the process of learning. In fact this could be a good model of memory.

The question is: Can we modify this process so as to improve the quality and quantity of our memory. This would be of immense help, especially when our memory starts failing during the old age. Several drugs and even RNA were fed to people and it was found that memory can be improved to some extent. In that case what are the drugs and other procedures which could improve the memory process and which may at least prevent the fading of our memory. Our preliminary observation before and six months after the Hatha Yoga practice by young volunteers convinced that we can improve the memory process considerably. This needs a more extensive study. It is presumed that it may be very helpful to improve the memory process in human beings. Similarly it is known that people

living in nutritionally dificient state in the developing countries are having poor turnover of proteins in their body. Since the memory is nothing but a turnover of RNA and protein synthesis, it is logical to expect that their memorizing power is also much less than of those living in more advanced countries. Can the memory power be improved in the people living in less advanced countries by using some of these yogic measures, especially with the help of Kundalini Yoga? This is a subject which needs extensive study and it has great relevance to the people living in these countries.

Homeostasis (Self-Regulation)

The human body maintains a constant internal environment even though our external environment continually undergoes changes. All the homeostatic mechanisms are regulated by body's hormones secreted by various endocrine glands. However, even this function is further regulated by the two parts of autonomic nervous system, sympathetic and parasympathetic. Since the entire autonomic nervous system and the endocrine system is controlled by the anterior and posterior parts of the hypothalamus, it can be stated that the entire mechanism is controlled by this region of the brain. It has also been observed that the hypothalamic region is further supported by the limbic system including amygdala, hippocampus and several other minor structures. It is this limbic system which is predominantly responsible for the regulation of homeostatic mechanism. This system carries on its regulatory functions through the Hypothalamic region. Amongst the various functions conducted by the hypothalamus the regulation of temperature, eating and drinking are very important ones. This area also regulates our emotions such as anger and fear. A particular emotional state is further regulated by the amygdala which is a part of the limbic system.

Sex

The entire sexual behaviour both in men and women is regulated both by the endocrines and the brain, especially the

limbic system and hypothalamus. Here we should remember that even the release of hormones is regulated by the hypothalamus. In fact, there is an area on the hypothalamus, the electrical stimulation of which stimulates the sexual activity in animals. Thus it is safe to conclude that it is the nervous system which regulates the release of sex hormones which would control the sexual activity of individuals. Therefore if one wants to regulate the sexual functions, one can do so to a considerable extent by influencing one's emotional and behavioural patterns. It is here that the practice of celibacy or *Brahmacharya* through Yoga has its importance and it is high time that further investigations are conducted to ascertain how easily one can regulate the sexual activity in order to maintain a good physical and mental health.

Sleep

It is comparatively recently that the reticular activating system was discovered and later on it was also found that it is the centre regulating the states of wakefulness and sleep. Through this reticular formation the neurons constantly send sensory information to the thalamus and cortex in order to keep them awake and alert. In the absence of these stimuli from the reticular formation a person goes to sleep. This reticular formation has a dual system, and all the sensory axons from the sense organs to the cortex put out branching axons to the reticular formation. Therefore, sensory information that goes to the cerebral cortex is also analysed alerted by the reticular formation. If such asousal by the reticular activating system could be increased by any means such as drugs or yogic practice, that may improve the learning process of the individual. It has been observed that drugs like amphetamin, benzamine, dexadrine and drynamyl were in extensive use, especially by the student communities to improve their performance during the examination days. However, all these drugs on a prolonged use produce so many behavioural changes that they are not at all safe to use save under very exceptional circumstances. Yogic practices, especially the more vigorous ones, such as

Kundalini Yoga, are very likely to he helpful here. But this needs further study.

Psychological disorders and Psychotropic Drugs

Amongst the psychological disorders neurosis and psychosis are the improtant ones from the common man's point of view. Amongst the neuroses, anxiety, depression and hysteria are the important forms. Amongst the psychoses, the most important one to note is schizophrenia. Laboratory examinations of blood, urine and cerebrospinal fluid usually do not show much abnormality in ordinary tests. However in recent years enormous amount of work has been carried out with regard to the neurohumoral contents and their degrading enzyme levels. In all these special investigations quite a number of biochemical changes were noted. Thus in anxiety neurosis, there is always an increase in the acetylcholine and cholinesterase contents, whereas in depression all the neurohumoral contents were found low. In schizophrenia there has been found much disturbance in the catecholamine metabolism, especially in the level of degrading enzymes such as Monoamine oxidase and COMT. Because of the deficiency of these enzymes, which is probably genetically transmitted, the patients usually have abnormally high content of catecholamines in the blood and other bodily secretions. It is really difficult to treat all these different psychological disorders with any suitable drug.

However in acute cases one has to use appropriate drugs to overcome the neurohumoral abnormalities. Thus appropriate drugs such as sedatives, tranquilizers, antidepressants and psychotomizetics should be used judiciously to tide over the acute situations. However, as soon as circumstances permit some type of yogic practices should be introduced gradually. At first only the *Hatha Yoga* practices such as *asanas* (physical postures) and *pranayama* or breathing exercises should be undertaken. This should be supplemented by the practice of relaxation postures such as *shavasana* for 30 minutes daily. Gradually one can introduce some mild type of meditation to

be followed by more vigorous type including Kundalini meditation. If a patient regularly practises all the yogic exercises mentioned above, his drug requirements will gradaully become less and he will feel better and better everyday. At last within the period of two to three months he can completely stop his medicines so that he can remain on yogic practices alone. The only drawback in this yogic treatment is that it will have to be practised regularly everyday and no one can afford to become irregular in it. If one stops these practices in between, the diseases are bound to come back with vengeance. The patient should therefore make it a point to do the yogic practices regularly at the fixed time. This will ensure him a healthy physical, mental, social and spiritual life. It may be noted that one of our Research Fellows who had an attack of psychophrenia could overcome his trouble completely by the regular practice of *Kundalini Yoga*.

Summary

Physiologically speaking, it seems that the main aim of the practice of *Kundalini Yoga* is to attain at first a voluntary control over the autonomic nervous system. This is usually followed by activation of the different centres of brain by transmitting certain specific neurohumors to these areas. In order to achieve this, steps are taken in stages. The main principle underlying the practice of *Kundalini Yoga* is to arrange maxmimum supply of oxygen to each *chakras* and other centres so that they become awakened and active. In view, of this, *pranayama* becomes the essential part of the practice of *Kundalini Yoga*. The most simple procedure is concentrating on these *chakras* while performing *pranayama* for two minutes, and then going upwards from *Muladhara* to *Sahasrara* one by one from the front part of the body and coming down step by step from backside. This roughly takes about half an hour. This can be preceded by yogic *asanas* and followed by meditation for a short period which may take another 15 minutes.

We started this study recently and our observations are, therefore, preliminary. Before we started this study, we consulted several people including a yogi who wanted to remain anonymous. We are using these techniques on healthy persons and also on patients with anxiety neurosis. Our preliminary observations on healthy persons indicate that it produces a great restraint on the emotional and other psychological disturbances. In the case of patients with anxiety neurosis and manifestations of psychological distrubances, it proved very helpful in calming down their entire psychosomatic apparatus. Our first patient who had a sudden and severe nervous breakdown leading to psychosis could be brought back to complete normalcy by a regular practice of *Kundalini Yoga* for two months. This person is well and has been doing his normal activity for more than two years. He still continues to practise this *Yoga*. Similarly, there are 24 other patients of anxiety neurosis who have been practising it for a shorter period. Since these preliminary observations have yielded some positive results, we have started a detailed scientific study both on healthy persons and also on patients with various psychosomatic disturbances. Suffice it to say here that the regular practice of *Kundalini Yoga* can do enormous good to every person especially in regulating the functions of the nervous system.

In short, it is now very likely that if one can regularly practise this *Yoga* for a prolonged period, one might one day experience the sudden awakening of *Kundalini*, which is very well described by Gopikrishna in several of his treatises. It should be remembered here that even without such awakening, one can derive a maximum benefit from it by a regular practice. One can calm down one's emotional disturbances and enhance one's intellectual activity through the *Kundalini Yoga*. It seems that our ancient sages had used this technique for their enormous contributions to philosophy, religion and culture. It is high time that we should revive the use of this and other similar yogic practices for the benefit of man. Thus, *Kundalini Yoga* is a great weapon which can be used with profit by anyone who wants to uplift himself and others to serve the humanity at large.

CHAPTER 15

Hypertension

Enormous amount of work has already been done in recent years in the field of hypertension, especially with regard to its etiology, pathology and management. Still the incidence of this disease is increasing throughout the civilized world. It is surprising that in spite of all the progress, the exact cause of hypertension is not yet known, as a result of which no preventive measures could be undertaken. Many people feel that it is not a disease entity, but only a product of several etiological processes which ultimately lead to the development of hypertension as one of the manifestations.

ETIOLOGY

As discussed earlier, usually in all these cases of stress disorders, etiological factors can be divided into two groups: (*a*) Genetic and (*b*) Environmental. It is known that several members in the same family may be having hypertension. And a type A personality with excessive drive, aggressiveness and ambition may be more liable to have hypertension and coronary heart diseases than a type B personality with opposite features. Our own studies indicated that a mesomorphic constitution with greater capacity for turnover of catecholamines and their enzymes is more likely to develop cardiovascular diseases, especially hypertension than others.

EXPERIMENTAL EVIDENCES

In experimental animals also this has been proved by many workers. Okamota has developed a special strain of rats which develops hypertension spontaneously before the age of 12 weeks. This would indicate that genetical traits may play some

important role in the development of hypertension. Similarly, there are also certain inbred strains of rats which genetically become salt sensitive and which on administration of salt become hypertensive. In all these cases, the common site for the development of these traits is the brain, especially the hypothalamic region, because, injection of 6-Hydroxydopamine which prevents the action of catecholaminergic fibres, into the lateral ventricle of the rats of spontaneously hypertensive strain, prevents the development of high blood pressure. However, this is effective only if it is done before they are 10 weeks old. If this injection is given after this period, when the high blood pressure has already developed in these rats, the treatment with 6-Hydroxydopamine does not lower the blood pressure. It may not be out of place to mention here that in these strains of rats, once the high blood pressure levels are established one of the importnt agents which lower the blood pressure is an inhibitor of serotonin synthesis namely parachlorophenylalanine. All these findings show that noradrenergic and dopaminergic neurons in the hypothalamus are involved in the development of hypertension and that all the various etiological agents operate through these neurons. However, this matter will be further dealt with later.

ENVIRONMENTAL FACTORS

It is known that the urban population is suffering from hypertension more than the rural, because the former group is more exposed to emotional stress than the latter. In fact, hypertension seems to be more consistently related to environmental psychosocial stressful situation which requires a constant behavioural adjustment on the part of the individual. A rapid cultural change, migration to different environmental settings, migration from primitive societies to highly developed urban areas are some of the examples which might be responsible for inducing hypertension in an individual. Similarly, a rapid socio-economic mobility, such as a rich man suddenly becoming poor or vice versa may lead to hypertension. In fact, the life of educated persons living especially in the urban areas is associated with constant struggle for existence which results

in uncertainties of life situations. It is these persons who constantly worry over the rapid environmental changes and who do not themselves have the ability to adapt adequately to face these changing life situations, who are likely candidates for the development of hypertension.

PATHOGENESIS

Experimental: There are several methods of producing hypertension in experimental animals. Thus, one can produce hypertension in mice by giving environmental psychosocial stimuli in the form of overcrowding, mixing of two or more dominant males with one female, chronic territorial conflict and similar other situations for a period of six to twelve months. In monkeys by following the chronic avoidance technique in which these animals are required to press a lever to avoid shock, hypertension can be caused in about 15 days. In dogs, by the application of classical and operant conditioning technique in the form of repeated painful sensory stimuli associated with light or tone signal followed by exhibition of only light or tone, elevated blood pressure can be caused. All these three environmental types of psychic stress resulted in a continuous behavioural adjustment which ultimately led to the development of hypertension.

Similarly, the chronic stimulation of regions of hypothalamus leads to an integrated response involving a rise in blood pressure, constriction of splanchnic, renal and skin vessels, and dilatation of the vessels of skeletal muscles. These responses are due to general activation of the sympathetic nervous system which is associated with the emergency reaction of fight or flight as described by Cannon. Further, one can also assume that such an elevation of blood pressure following electrical stimulation of hypothalamus may closely resemble the condition of hypertension developing after chronic psychic and emotional stress.

The baroreceptors in the carotid sinus and aortic arch normally maintain blood pressure within the physiological limits. In case of hypertension, they are reset at a higher level. In experimental animals if they are sectioned, one can get

hypertension following any of the environmental stimuli. On the basis of results of above experimental methods, it can he said that brain, especially the hypothalamic region, plays an important role in the development of hypertension. In fact, it is one of the best examples of psycho-social stress causing a psychosomatic disease.

OTHER METHODS

But there are a few other methods of producing hypertension, in which the role of brain was not clear till recently. However, recent studies have further clarified the matter. It is known that experimental hypertension can also be produced by treating rats with DOCA and salt, by constricting the renal artery or tightly wrapping the kidney. Similarly, reference was also made earlier to the genetic strains of hypertensive rats, such as salt sensitive and spontaneously hypertensive strains. It seems that in all these cases the centres in the brain may not be playing any role in the causation and maintenance of high blood pressure. However, recent studies have indicated that this impression is not correct and that brain participates in everyone of these forms of experimental hypertension. Thus in rats, the DOCA and salt hypertension is associated with increased release of catecholamines from the sympathetic nerve endings and adrenal medulla. In such animals, if 6-Hydroxydopamine which destroys the catecholaminergic neurons, is instilled into the ventricles, the peripheral sympathetic nerve discharge becomes less. This ultimately leads to the prevention of DOCA and salt hypertension. However, once the hypertension has already developed, instillation of 6-Hydroxydopamine into ventricles does not lower the blood pressure. High blood pressure produced by constricting the renal artery can also be prevented in the same way by the intraventricular instillation of 6-Hydroxydopamine.

It is now well established that renal artery constriction causes release of renin and thus increases angiotensin II production. This substance, in addition to its other effects, causes powerful pressure effects in the brain which is mediated by the catecholaminergic neurons of the brain stem and hypothala-

mus. This leads to increased peripheral sympathetic discharge leading to increased blood pressure. If the effects of angiotensin II can be blocked by depleting the catecholamines of brain by 6-Hydroxydopamine, no high blood presure occurs. In the same way in the sopontaneously hypertensive rats also, if 6-Hydroxydopamine is injected into ventricles before the age of 10 weeks, hypertension can be prevented in these animals.

All these experimental studies indicate clearly that the hypothalamus and brain stem fully participate in the development and maintenance of every form of experimental hypertension. Although these experimental findings cannot be fully confirmed in the human situation, it does indicate that the catecholaminergic nerve endings in the brain stem and hypothalamus might be playing significant role in the predisposition, initiation and maintenance of hypertension in human beings also.

CLINICAL STUDIES

It is known that whenever a person is exposed to psychosocial stress, there occurs a transient rise in blood pressure as a result of sympathetic nerves releasing noradrenaline both at the centre and the peripheral nerve endings. If such a situation continues for a long time as a result of repeated and prolonged emotional disturbances, the patient in the beginning goes into a labile phase of hypertension with high cardiac output and normal peripheral resistance. Gradually, as time passes, this pattern changes towards normal cardiac output with higher peripheral resistance which does not occur in all the vessels of the body. Thus the renal, splanchnic and cutaneous blood vessels develop excess of peripheral resistance and the vessels of the skeletal muscles develop much lower peripheral resistance. The increase in peripheral resistance is dependent upon the disproportionate constriction of visceral and cutaneous vessels which is in excess of skeletal muscle vasodilatation. One should remember here that these haemodynamic changes seen in hypertension are similar to those noted during emotional stress and are also analogous to the state seen after the electri-

cal stimulation of hypothalamic centre in experimental animals. This further confirms that all these changes are due to the excessive release of neurohumors from the catecholaminergic nerve fibres at the brain stem. It can be very well realized that when an excess of catecholamine circulates in the blood it can readily produce constriction of peripheral (Table 2) vessels leading to the development of hypertension. Initially it remains labile. However, later on as the blood vessels become hardened, high blood pressure becomes a constant feature. If this high pressure continues for a long time, the vessel walls become weak and develop some tears here and there. These tears are usually repaired by deposition of cholesterol plaques in the vessel wall. When there is an excesive number of plaques, the vessel wall becomes narrower and narrower as a result of blockage. This leads to further increase in the blood pressure. Sometimes the plaques may get themselves detached from the arterial wall and cause further blockage of the vessels of vital organs like heart, brain etc. and initiate clotting.

In addition, high blood pressure may directly affect the heart since it has to pump blood through greater pressure to overcome the enhanced peripheral resistance. Thus the left ventricles become hypertrophied and then go into a state of failure. Thus, the patients of hypertension succumb sooner or later to myocardial infarction, cerebral apoplexy, or congestive heart failure. From these observations, one can very easily realize how recurrent psychological stress can ultimately produce such a dangerous situation for life in the course of time. Depending upon the various factors, such as personality and behaviour of the person concerned and the nature and severity of stressful situations in hypertensive patients, death may supervene within a short period after the onset of the disease, whereas in others the patient may remain apparently healthy for many years.

Management

Usually all the medical measures are directed towards lowering of blood pressure so that one could prevent the danger to

Table 2.

Showing Total Plasma Catecholamine in Different Degrees of Hypertension
(Bhat, G.K., Vaish, S.K. and Udupa, K.N.)
(Unpublished Data)

Cases	Catecholamine		
1. Controls	252.4	ng/ml	
(24)	± 35.73		
2. Essential Hypertension:			
(*a*) Mild	290.0	ng/ml	Diastolic Pres. from 95 to 110 mm. Hg.
(32)	± 11.40		
	0.1		
(*b*) Moderate	309.0		
(8)	± 8.306		Diastolic B.P. 110 to 125 mm. Hg.
	0.01		
(*c*) Severe	349.0		Diastolic B.P. above 125 mm. Hg.
(6)	± 34.92		
	0.01		
3. Malignant Hypertension with complications	337.0		
(11)	± 19.02		
	0.01		

vital organs. In the early stages, the physician usually prescribes some tranquillizers like Diazepam. Similarly the use of Methyldopa is also found to be useful in controlling hypertension which acts through the hypothalamic region by reducing the activity of catecholaminergic fibers there. The reserpine group of drugs also has a similar action in reducing the blood pressure. But in addition, these drugs also tend to decrease the release and reuptake of noradrenaline from the synaptic junctions of sympathetic nerve endings. Similarly the use of beta adrenergic blockers such as propranolol has become very popular in recent years in properly selected cases with evidences of excess catecholamine turnover. Their main action is at the receptor level and hence the results are sometimes dramatic in otherwise very resistant cases of hypertension. In addition to these specific drugs, which mostly act on the neurohumoral output from the sympathetic nervous system, diuretics have also been tried with beneficial results in a certain percentage of cases.

However, one must admit that all these medical measures have their limitations. The tranquillizers are habit forming and hence they cannot be used for a very long time without risking the development of drug addiction in a certain percentage of patients. The reserpine group of drugs, if used for a long period, have also caused many disabilities in individual cases, such as depression, suicidal tendencies, loss of libido, allergic manifestation, etc. Further, recently there have been reports to indicate that prolonged use of reserpine in women may predispose them to develop cancer of the breast. In the same way, the prolonged use of powerful antihypertensive drugs may lead to some complications in certain part of the body. In the developing countries, the high cost and difficulty in maintaining efficient supply of drugs may also preclude the use of these drugs for a life-long period. Hence, there is an urgent need for a newer approach to the problem of management of essential hypertension.

URINARY CATECHOLAMINE IN HYPERTENSIVES BEFORE AND AFTER THREE MONTHS OF YOGIC PRACTICES

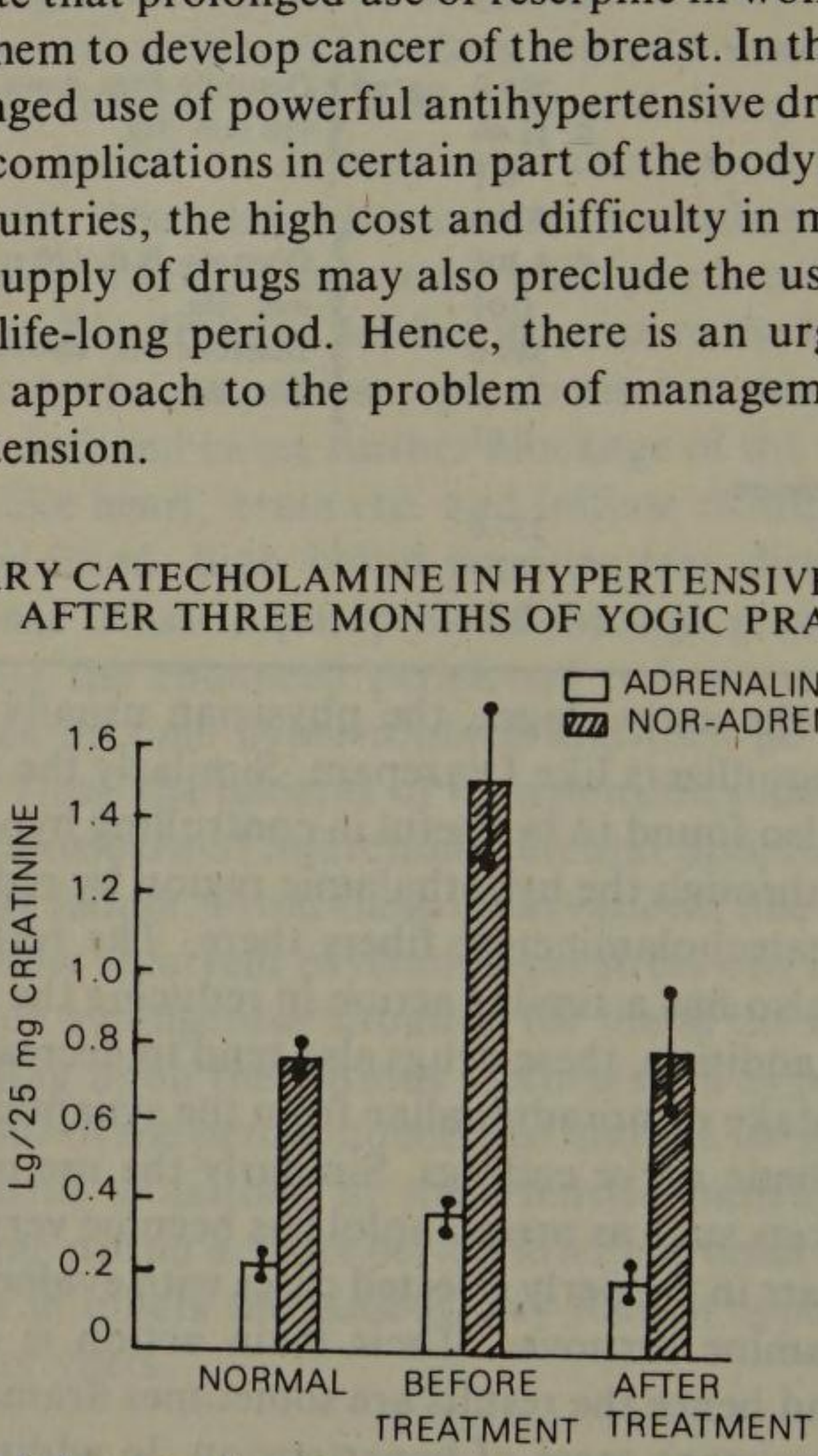


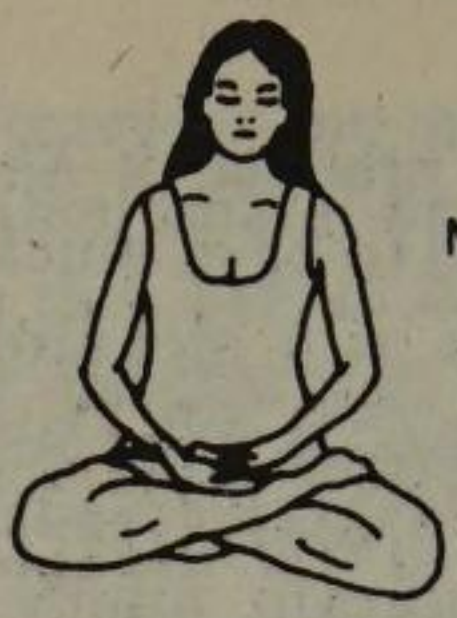
Fig. 49. In hypertension, the urinary excretion of adrenaline and noradrenaline increased by about 100%. However, after the practice of *Shavasana* there was a complete normalization of excretion of these substances in 3 months along with reduction of blood pressure.

Yogic Measures for Hypertension

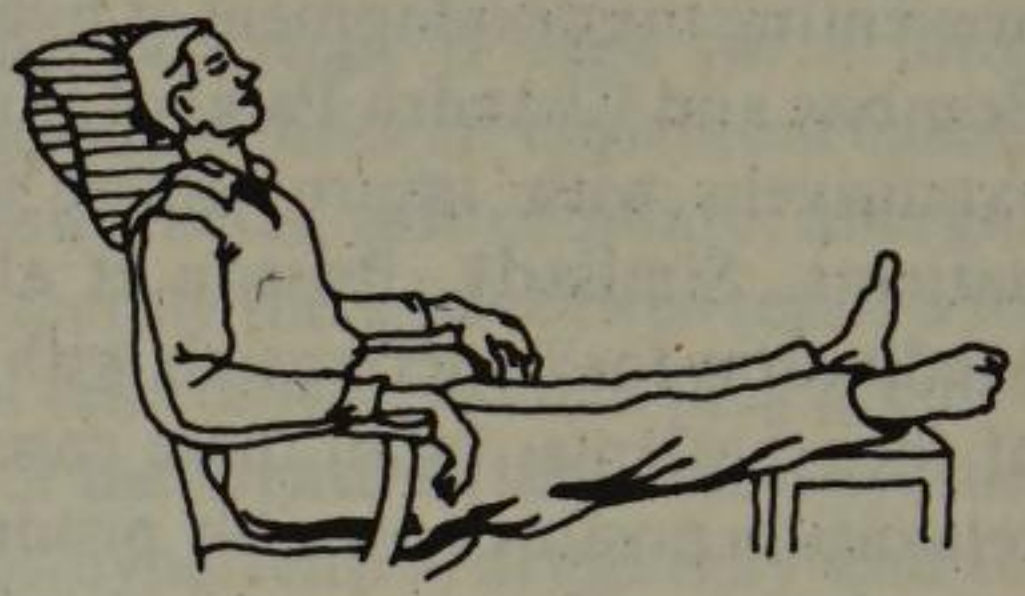
Amongst various yogic measures, the practice of *Shavasana*, a yogic relaxation posture, was found to be of much use not only as a curative measure, but also as a measure for preventing the development of hypertension (Fig. 49). Datey of Bombay and Chandra Patel of London used this method quite extensively with improvement in a significant number of patients. Similarly, Benson et al have used Transcendental Meditation for hypertension with good results in the majority of their patients. In all these cases it was postulated that the relaxation postures possibly produce their beneficial results by reducing the adrenergic and noradrenergic activity in the brain stem and the peripheral organs and tissues. (Fig. 50).

PHYSIOLOGICAL STUDIES

In order to study this problem in greater detail, we at first selected 6 young healthy female volunteers in the age group of 20 to 25 years. They were given *Shavasana*, a well known yogic relaxation posture, for 30 minutes every day for 3 months. In this posture they were asked to lie down on the floor without the support of pillow and were asked to attain full relaxation of all the muscles of the body gradually. Thereafter, they were asked to have complete psychic relaxation as far as feasible during the period of postural relaxation. We modulated the results of these measures by recording pulse, blood pressure, body weight, plasma cortisol, total catecholamines and histamine. These studies indicated no significant changes in any of these parameters after 3 months of practice of *Shavasana* except in respect of total catecholamine contents of the blood. There was a significant reduction of total catecholamine of the blood in all the subjects who underwent a course of *Shavasana*. This is in contrast to a group of volunteers who underwent a course of physical exercises in our gymnasium during this period. In all these people the catecholamine content increased significantly. This would clearly indicate that muscle relaxation in any form such as *Shavasana* or any other relaxation postural method would certainly produce considerable reduc-



MEDITATION



MEDITATION & RELAXATION

RELAXATION

Fig. 50. Shows different postures commonly used in the treatment of Hypertension. These will have to be individualized depending upon the circumstances and stage of the disease. Meditation is better as a preventive measure and Relaxation is good as a curative treatment.

tion in the catecholamine turnover leading gradually to reduction of blood pressure. Encouraged by these physiological studies we applied this technique to our clinical cases of hypertension (Figs. 51,52).

CLINICAL STUDIES

This study (unpublished) was conducted by Dr. S.K. Agrawal, Prof. S.K. Vaish and myself in our Institute Hospital. It was conducted on 50 people; of these 25 hypertensive patients were selected at random from the hypertension clinic. Five out of these 25 cases were given drug treatment before they were selected for this study. For the sake of comparison 25 normotensive people were also included as controls. All these 50 people were at first observed for six to eight weeks without any therapy for stabilization of their blood pressure. Thereafter, all of them were subjected to the practice of *Shavasana* for 30 minutes daily for 3 months. During this period, blood pressure

EFFECT OF YOGA AND HYPOTENSIVE DRUGS ON HYPERTENSION

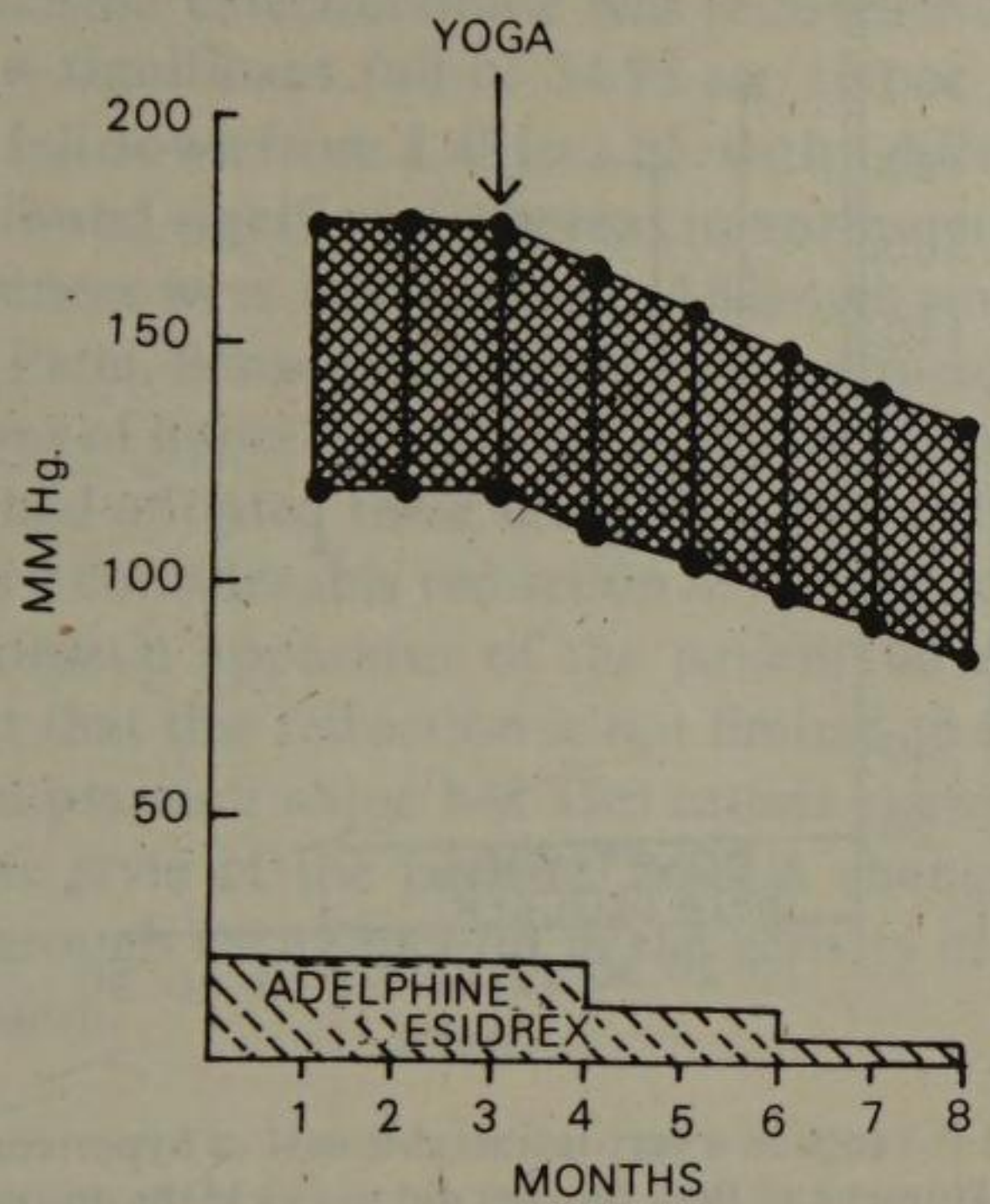


Fig. 51. Shows BP of an intractable case of hypertension in which anti-hypertensive drug alone did not give much relief. An addition of yogic practice greatly helped to reduce the blood pressure in the next six months.

was checked under lying down posture at weekly intervals for a proper comparison. During this period, plasma cortisol, plasma catecholamine and urinary VMA were also studied before, during and after the *Shavasana* treatment. For the sake of comparison these patients were divided into 3 groups: (A) 20 patients of essential hypertension without any drugs, (B) 5 patients who also received drug therapy and (C) 25 normotensive subjects. All these people were subjected to treatment by *Shavasana* or relaxation posture for 30 minutes in the morning and evening everyday.

Results of these studies indicated that *Shavasana* significantly reduced the blood pressure, both systolic and diastolic. Thus in group A patients the systolic BP came down from the mean level of 153.3 mm Hg to 139.3 with a difference of 15 mm Hg in 3 months. Similarly, the diastolic pressure came down

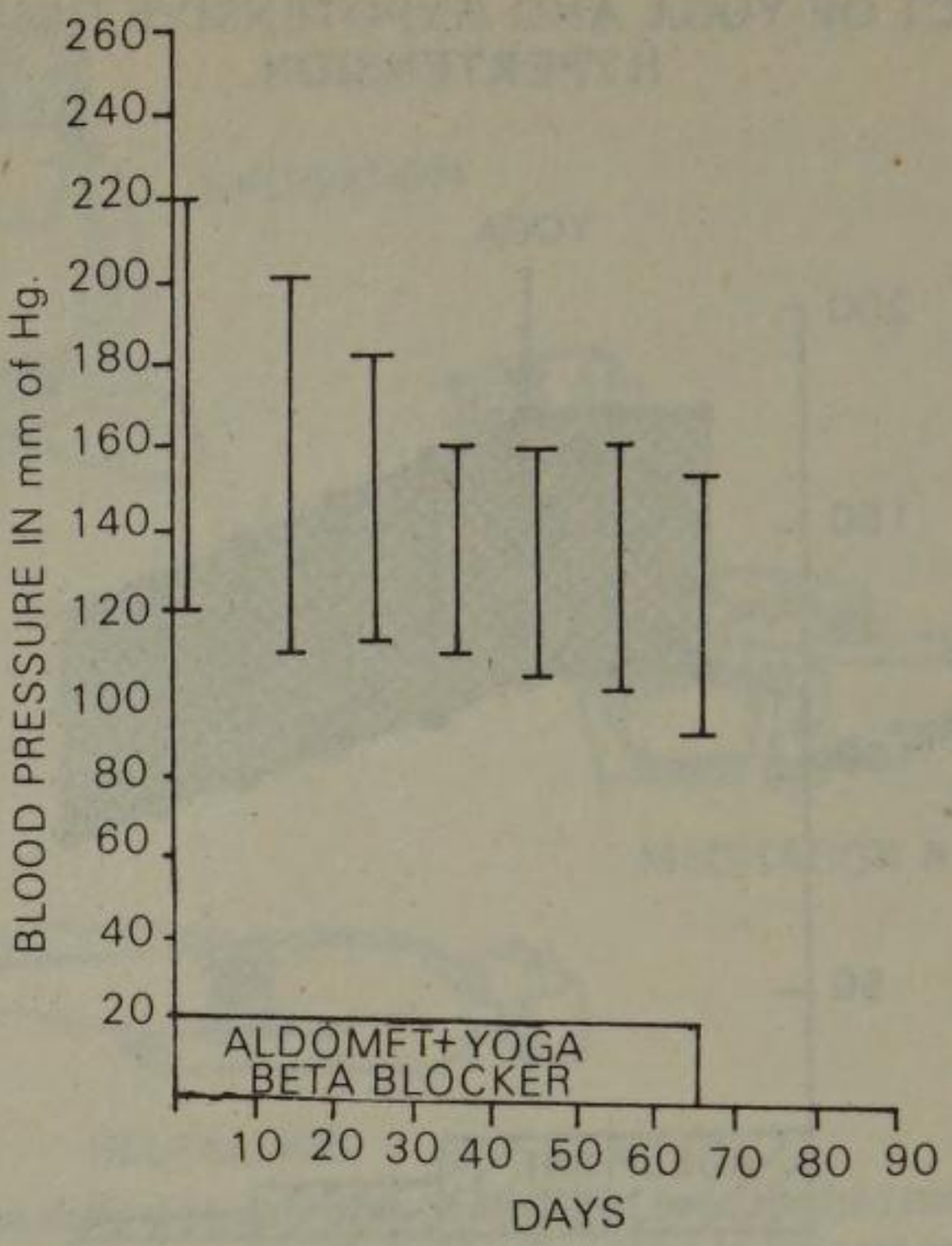


Fig. 52. Shows B.P range in a very intractable case of hypertension in which the use of both aldomet and Beta Blocker did not yield the desired result. The addition of *Shavasana* produced considerable improvement in B P in the next two months.

from 102.7 mm Hg to 90.4 mm Hg amounting to a fall of 12.3 mm Hg at the end of 3 months. On further study we found that these beneficial results could be seen significantly in about 65% of the cases, whereas in others the results were equivocal.

In group B patients who received *Shavasana* and drug therapy, the results were more significant with a fall of systolic pressure of 31.2. mm Hg and the diastolic pressure of 18.8 mm Hg. This indicates that in cases of hypertension if *Shavasana* is combined with drug therapy one can get more significant result in a shorter period of time. 80% of these cases showed very impressive results when combined with drug therapy. On the other hand, in the normotensive subjects the differences in the systolic and diastolic pressure were insignificant.

In these cases, the clinical observations were further supported by laboratory findings (Tab. 3). Thus in 15 cases the plasma cortisol, catecholamine and urinary VMA were esti-

mated. After *Shavasana* the plasma cortisol level was reduced from 27.4 to 25.2 with a significant fall by 2.47 μg/100 c.c. Similarly plasma catecholamine was reduced from 289.82 to 234.91 i.e. a significant fall of 54.91 μg/100 cc. The urinary VMA level fell down from 2.48 to 2.05, with a difference of 0.43 which was found significant whereas in normotensive subjects these differences were insignificant. Although several workers like Datey, Patel, Benson and others had conducted the clinical investigations of hypertensive cases with relaxation therapy, so far no one had adopted these laboratory parameters to prove that there is a considerable reduction in the stressful condition of psychosomatic apparatus of the patients after *Shavasana* therapy and that this reduction is not limited to the reduction in the blood pressure alone but also causes changes in behaviour and life style of the patient. Such a change is possibly mediated through the reduction in the activity of sympathetic nervous system.

Table 3

Table showing the changes in Catecholamine, VMA and Plasma Cortisol in Hypertensive patients after 3 months' *Shavasana* (Relaxation) Therapy
(Agrawal, S.R., Vaish S.K. and Udupa, K.N.)
(Unpublished Data)

Estimation	No. of cases	Before treatment	After treatment (Shavasana)	P. Value
1. Plasma Catecholamine	15	289.82 ± 12.01	234.91 ± 13.07	0.001
2. Urinary V M A	15	2.48 ± 0.23	2.05 ± 0.23	0.05
3. Plasma Cortisol	15	27.49 ± 1.67	25.02 ± 1.74	0.001

CHAPTER 16

Stress and the Disorders of Heart

As discussed earlier, heart is well connected with hypothalamus through the sympathetic and parasympathetic nerves, so that all emotional or psychic changes are soon followed by changes in the function of heart and similarly, if there is any change in heart, say with regard to its blood supply, it is soon transmitted through visceroceptors to visceral centres of brain leading to successive changes in the limbic system, hypothalamous and heart. Thus, both the external environmental exciting factors and internal psychosomatic stress factors can influence heart and its function to a considerable extent. Therefore, if these exciting factors continue for a long time in a person with a weak heart due to environmental or genetic causes, he is bound to get the disease sooner or later depending upon various other predisposing factors. Coronary insufficiency, angina pectoris and myocardial infarction are some of the commonest conditions causing high mortality and morbidity in most of the countries. In addition, it is most alarming to note that these conditions are increasing every year in most of the developed and even in the developing countries, as they are becoming more and more civilized. Further, it is also becoming evident that death due to coronary vascular disease in the younger and middle aged people is increasing in most of the countries. What, indeed, are the various contributing and exciting factors for such a rapid increase in the incidence of these diseases in the civilized community? One of the obvious factors in the affluent communities of modern cities is that they eat too much and do too little physical work. Too much intake of fat is obviously responsible for the early development of atherosclerosis, though this has not been conclusively proved so far. Similarly, lack of physical exercise in these people is

another important factor which predisposes these people to develop coronary artery disease. It is known that muscular exercise improves circulation of the entire body including that of the heart and because of this there is no stagnation of circulation nor is there any blockage of smaller vessels in the early age. However, in the absence of physical exercise all these factors may operate so as to predispose a person to develop coronary artery disease. Similarly,,excessive smoking, drinking too much of coffee and other similar beverages may also contribute to the development of this disease as a result of excessive release of catecholamines. In addition to this, the genetically inherited susceptible or 'weak heart' is another important hereditary factor which makes a person more vulnerable to the development of this disease than others. These are some of the predisposing factors, all of which may play some role in the causation of the disease. However, the most important exciting factor for the development of the disease is emotional stress.

Role of Emotional Stress

Usually psychological excitements of short duration do not produce serious disturbance in coronary circulation in persons with healthy heart or arteries. However, in people with any of the predisposing factors already operating repeated and chronic psychological stress may increase the susceptibility to the development of the coronary artery disease. It is more common in relatively young people with a high degree of professional responsibility. Thus, a young susceptible person with high ambitions, such as one aspiring for the Headship of some big organization is more liable to get heart attacks if he is exposed to recurrent emotional stress. I have known a very able and efficient Civil Engineer, who, because of his very hard work, rose to the position of Chief Engineer of a State at a relatively young age of 42 years. He unfortunately became a victim of heart attack and died within a year of his attaining the high position in view of the constant stress he received from his colleagues who were highly critical of his performance. One

can quote many such examples, for it is frequently observed that a patient of coronary heart disease usually has a very demanding job involving constant emotional stress, a job in which the responsibility that goes with the high position is more significant than the actual performance of work itself. Thus, the managers of big factories are more liable to get this disease than the subordinate workers with no responsibility for the output of their products. Further, those men who perform physical work along with their high intellectual activity are less liable to develop this disease than those who constantly do overwork mentally. Here one should also remember that some people react to stressful situations more intensely than others and hence such people with a high degree of sensitivity to a given situation are more liable to get this disease.

PATHOPHYSIOLOGY

It is now well known that the emotional stress causes disturbance in hypothalamus which is also the centre for sympathetic and parasympathetic nervous system. Therefore, whenever there is constant excessive stress, the sympathetic nervous system is stimulated which increases the activities of heart and circulation leading to rise of blood pressure, heart rate etc. Such an increase in the activity of the sympatho-adrenal system leads to excessive liberation of adrenaline and noradrenaline which further enhances the activity of heart without the corresponding increase in the oxygen supply to the myocardium. This leads to insufficiency of coronary circulation giving rise to various manifestations of angina pectoris. However, if such a situation is allowed to continue for a longer period, it may lead to coronary thrombosis at a later date. Normally when excessive catecholamines are formed they are neutralized by various degrading enzymes and also by acetylcholine. However, if there is too much of stress these antagonizing mechanisms fail and the patient develops the clinical features of coronary insufficiency. Many times, the clinical features of this condition itself may cause anxiety in these patients which may further interfere with the coronary circula-

tion. Thus, various environmental disturbances cause psychic stimulation as a result of increased activity of the psychic centre of brain. From here the stimulation reaches hypothalamus via the limbic system causing emotional disturbances and excitement of the sympathetic nervous system. These changes in hypothalamus lead to excessive liberation of catecholamines without the corresponding increase in their degrading substances. If such a situation is allowed to continue for a long time in a person with a sensitive and susceptible heart, it leads to the development of coronary insufficiency with manifestation of angina pectoris. However, if the person is already having the features of coronary artery sclerosis, the severe mental stress may lead to the development of sudden heart attack or coronary thrombosis.

MECHANISM OF CORONARY ARTERY SCLEROSIS

It should be remembered that psychic stress not only causes neurohumoral changes, but also results in various metabolic changes. It is now well established that the excessive outpouring of catecholamine and cortisol causes increased glycogenolysis and gluconeogenesis. In addition, severe stress also leads to marked increase in the serum cholesterol level. This indicates that nonesterified fatty acids can be easily mobilized from the adipose tissues during stressful situation. In addition, excessive production of adrenaline and noradrenaline may increase the intimal absorption of lipids leading to damage to the vascular tissue. Further, it has also been proved experimentally that the deposition of cholesterol in the intima can be accelerated by the excessive use of adrenaline. In fact, emotional stress would seem to increase the possibility of abnormal lipid deposits. This would be so particularly in a subject loaded with freely circulating fatty molecules as a result of excessive mobilization of lipids from their depots or as a result of excessive dietary intake of fat. Once these lipids and cholesterol modecules are deposited in the subintimal space, the lumen of the vessels gradually get narrowed down. Gradually these lipid molecules become calcified, when the full fledged features of

atherosclerosis become manifest. This will fully explain how chronic emotional stress can lead to the development of arteriosclerosis, especially in the vital vessels such as in coronary arteries or in the arteries supplying the brain.

In addition, stressful situation also increases the viscosity of blood and decreases coagulation time. The decrease in coagulation time occurs as a defence mechanism to prevent bleeding during emergency. However, if such a situation continues for a long time it may do more harm than good. Thus, a prolonged stressful situation with increased viscosity of blood and decreased coagulation time may result in the early development of arterial thrombosis in a vessel which is already constricted due to subintimal deposition of lipids. Hence, chronic emotional strain can hasten the development of atherosclerosis and coronary thrombosis through various factors mentioned above, especially in the people who take diet rich in fat, who resort to excessive smoking or who are already subjects of hypertension or diabetes mellitus.

ROLE OF STRESS DURING HEART ATTACKS

When chronic stress becomes superimposed with acute stress, many serious cardiovascular changes may set in, such as rapid heart rate with increased cardiac output, abnormalities in heart rhythm, changes in blood pressure, blood viscosity, blood clotting time etc. Such an acute situation develops whenever a patient suddenly develops coronary thrombosis with myocardial infarction. During this, there is a sudden increase in the output of adrenaline and noradrenaline leading to most of the changes mentioned above. Amongst them most serious and life threatening complication is the development of cardiac arrythmia. This subject was extensively studied by Bhat, Vaish and myself in a group of 83 patients admitted to the Coronary Care Unit of our Hospital. In these cases, neurohumoral levels such as acetylcholine, catecholamine, histamine and also plasma cortisol were estimated at the time of admission, and daily thereafter till the patient was discharged (Fig. 53). From these laboratory studies we could arrive at the

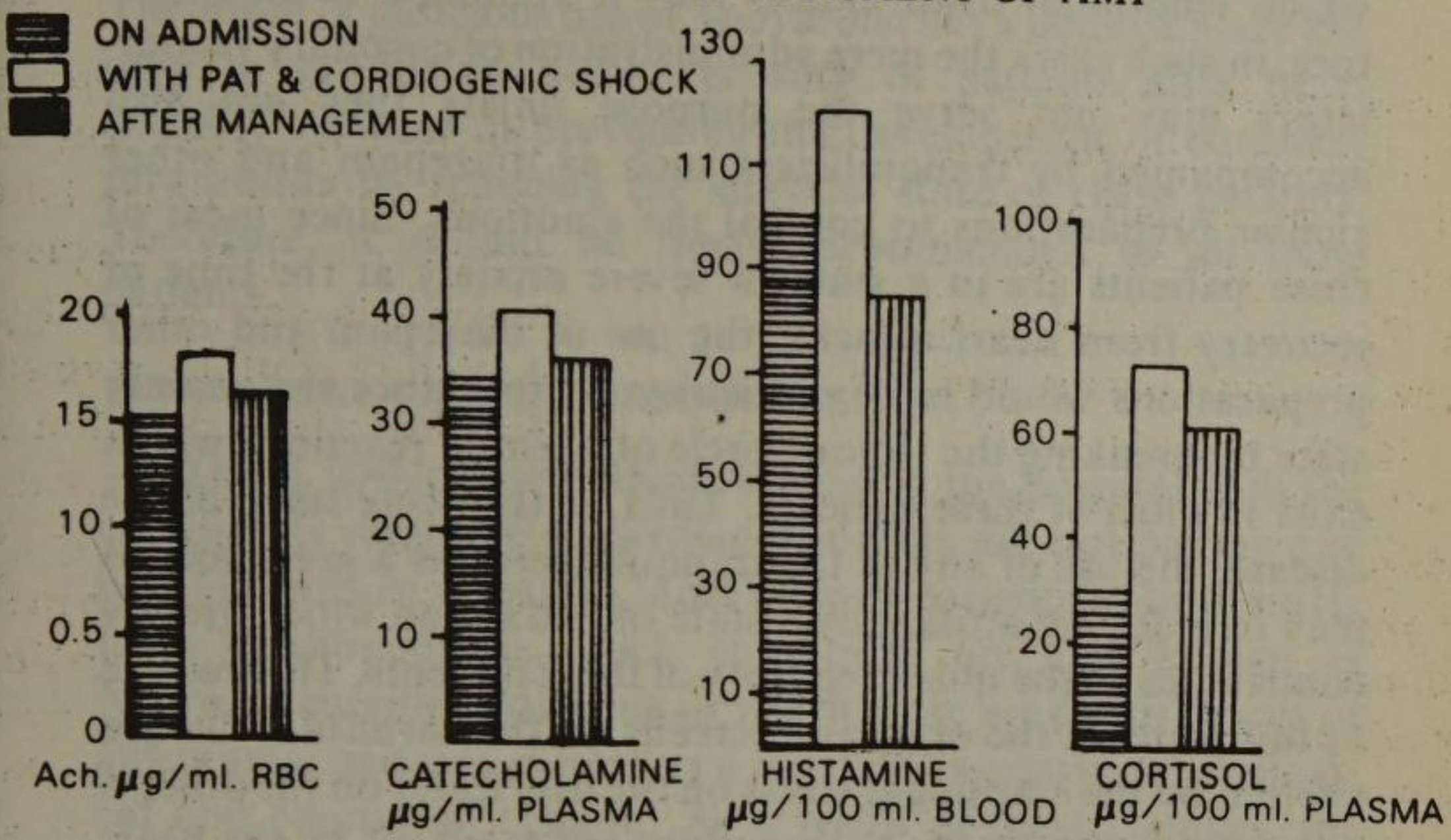


Fig. 53. Shows Neurohumors in Acute Myocardial Infarction. In these cases whenever there were complications of arrythmia and cardiogenic shock, all the neurohumoral content and cortisol increased. However, when the complications were overcome, these neurohumors also came down to a lower level. Thus neurohumoral changes are the basic factors for the development of these complications.

conclusion that there is a close correlation between the severity of arrythmia and the amount of catecholamine in the blood. The more severe the arrythmia, the higher was the catecholamine content of the blood. If the level of catecholamine gradually decreased, the patient fully recovered from arrythmia. If the catecholamine level increased to a higher level after admission, the patient usually succumbed to the disease. All these findings clearly indicate that during heart attacks, the estimation of plasma catecholamine and cortisol not only helps us to know the amount of stress that is operating in a given patient, but also would help us to assess the prognosis of individual cases. Hence, these investigations should be invariably carried out.

MANAGEMENT

It is now well established that coronary occlusion occurs as a result of many predisposing and exciting factors amongst

which emotional disturbances play a dominant role. Therefore, in such cases the mere administration of coronary vasodilators may not serve the purpose unless they are also accompanied by tranquillizers such as diazepam and other similar preparations to control the emotions. Since most of these patients are in a state of severe anxiety at the time of recovery from heart attacks, the use of diazepam and other preparations would be of particular use to reduce the anxiety state by breaking the vicious circle of harmful reactions which exist in most of these patients. Thus, in the acute stage of the disease, the use of any of the tranquillizers has a great role to play in inducing artificially a state of relaxation which greatly contributes to the quick recovery of these patients. The free use of this drug on the one hand screens off the harmful influence exerted by the emotional stress on the heart, and on the other it tones down the emotional reactions triggered off by the heart disease itself and on the autonomic nervous system. In short, for sedation and relaxation in myocardial infarction, it is necessary to have a drug which has little effect on blood pressure and pulse rate. Hence for this purpose the diazepam in dosage of 5 to 10 mg three times a day seems to be an ideal preparation. Similarly, it also greatly helps to reduce the tension of patients with angina pectoris and coronary insufficiency. In all these cases use of coronary vasodilatation alone will not be of much use unless these patients are also given the tranquillizers simultaneously. If these conditions are associated with excessive plasma catecholamine one can also use the beta adrenergic blockers such as "Inderal" for preventing the development of cardiac arrythmia in the acute state. After overcoming the acute attack, one should continuously take proper precaution in preventing the recurrence of this disease. Similarly in angina pectoris and coronary insufficiency, one will have to prevent the development of acute attacks of coronary occlusion. In order to do that, the use of *Shavasana* or relaxation posture greatly helps these patients by reducing their catecholamine contents in the blood. This makes them gain more stress competence so that sooner or later they

become resistant to various types of environmental stress. Therefore, a judicious use of *Shavasana* has a definite place not only in producing quick recovery of patients after heart attacks, but also in preventing the development of coronary thrombosis by reducing the stressful state of these patients. Therefore, it should be freely recommended to all these patients.

FUNCTIONAL CARDIAC DISORDERS

About 50% of the patients attending the hospital with the complaints referable to cardiac disorders are not having any organic cardiac diseases. Most of such patients usually suffer from cardioneurosis. Such conditions are also known as Neuro-circulatory Asthenia in which there are disturbances of autonomic nervous system as a result of excessive psychological and emotional tension. As a result of these changes, the patients get dysfunction of cardiovascular system along with the disturbance in the emotional set-up. Thus, one of the important features of such a disturbance of cardiovascular system is the development of cardiac arrythmia. So far it was felt that cardiac arrythmia was thought to be only due to some organic changes in the cardiac musculature or in the coronary vessels. It is only recently that clinicians have realized that cardiac neuroses or functional cardiac disorders are the clinical entities which are caused by excessive psychic stress resulting into the functions of autonomic nervous system. In view of this, one must emphasize the fact that a large number of cases of cardiac arrythmia in which there occurs disturbance in the initiation and conduction of heart beat can occurs functionally without any local heart disease. In fact, anxiety and emotional tension are the most importnat extracardiac causes of cardiac arrythmia. Amongst various disorders, emotional tension and anxiety have been reported to be responsible for the production of following types of cardiac arrythmia: (1) sinus tachycardia, (2) sinus bradycardia, (3) sinus arrythmia, (4) extrasystoles, (5) paroxysmal tachycardia, and (6) pseudo-angina.

SINUS TACHYCARDIA

Physiologically this condition occurs as a result of physical exercise, increased metabolism or as a result of rise in temperature. In all these conditions there is increased stimulation of sympathetic nervous system leading to the development of tachycardia. In the same way emotional excitement may also cause sinus tachycardia as a result of stimulation of sympathetic nervous system. This situation can also be considered physiological. However, one will have to consider it pathological when the acceleration of the heart rate is too great or too prolonged. Similarly, it can be treated abnormal if the tachycardia comes up on slightest exertion or after a slight rise of temperature. In such cases, one will have to assume that there is hypersensitiveness of the psychic centre, which operates through the easily excitable centre of sympathetic nervous system in the hypothalamus. Sometimes a person gets tachycardia as a result of emotional disturbances and then he becomes anxious about his cardiac dysfunction which results in the further vicious circle of excitement and apprehension leading to tachycardia for a prolonged period. All these functional tachycardias can be successfully treated by a judicious use of tranquillizers with or without beta-blockers in the acute stage. However, for preventing such attacks of sinus tachycardia and also to minimize the duration of such attacks, yogic practices in the form of postures greatly help these patients. It seems that these yogic practices minimize the duration of such attacks; yogic practices in the form of postures greatly help these patients. It seems that these yogic practices minimize the psychic and emotional reaction to environmental stress leading to minimal sympathetic nerve activity and tachycardia.

SINUS BRADYCARDIA

This is comparatively a rare condition and it occurs as a result of an increased activity of the parasympathetic nervous system instead of the sympathetic on receiving some type of psychic stress. Here the pulse rate becomes low and the patient usually gets attacks of giddiness and fainting for a variable

period. Even in this condition is appears very often that one will have to treat with tranquillizers, such as diazepam, in the acute stage followed later on by yogic practice for getting lasting relief.

SINUS ARRYTHMIA

This condition occurs when both the parasympathetic and sympathetic nerves are stimulated alternately on receiving some severe emotional stress.. These people are usually very sensitive since birth and their autonomic nervous system is also genetically highly reactive. They are usually very creative personalities and can fall victim to this condition on the slightest provocation. Because the heart gets stimulus for developing tachycardia and bradycardia irregularly, it goes into the state of sinus arrhythmia. Thus, whenever the patient goes into a state of psychic excitement his heart starts beating irregularly but the moment the excitement subsides, the irregularity of the heart beat also stops and he goes into a state of regular heart beat. The seat of all these disturbances is the psychic centre of the brain which is situated in the frontal lobe and it can be rectified by the regular practice of Yoga and administration of tranquillizers.

EXTRASYSTOLES

Although the extrasystoles are usually considered to be due to organic lesions in the myocardium they can also occur as a result of emotional tension, psychic stress or dysfunction of autonomic nervous system. Hence one should remember that extrasystoles can occur even with healthy hearts in a large percentage of cases if the psychic stress is servere enough to cause such a functional disorder. Even here vicious circle phenomenon may set in and highly sensitive persons can develop extrasystoles with greater stroke volume preceded by a missing heart beat. Such a situation may perturb the patient too much which may trigger off further exacerbation of symptoms and signs leading to more of such extrasystoles. Therefore the major emphasis in treatment as stated earlier, should be psychotheraphy, tranquillizers and yogic practice.

PAROXYSMAL TACHYCARDIA

Paroxysmal tachycardia is one of the common functional cardiac disorders seen in association with anxiety and emotional stress. In this condition there occur attacks of tachycardia all of a sudden preceded usually by a stressful life situation. Some time the attack may come up at the slightest emotional stress and it usually leads to the feeling of severe palpitation and anxiety. This situation further aggravates the attack of tachycardia which sets in the vicious circle reaction. As the state of anxiety decreases the condition also gradually subsides by itself. However, the patient becomes so much disturbed by such repeated attacks that he loses his confidence to lead a normal life. Hence it needs a prolonged treatment on the lines mentioned earlier to get lasting relief.

PSEUDO-ANGINA

This is the condition commonly seen in young people who get dull pressure over the precardium for some time and then get an attack of sharp pain in the region of the heart. Often these patients get pain almost identical with that of true angina. However true angina usually shows a tendency to occur after physical exertion, sexual intercourse, cold stress or after heavy meals, whereas pseudo-angina occurs all of a sudden without any such exertion. In such cases alongwith pain in the precardium the patient also often gets certain respiratory symptoms such as sensation of strangulation of upper respiratory tract, a sensation of suffocation, laboured or stertorous breathing, dyspnoea etc. From these additional features of respiratory neurosis which usually accompanies pseudo-angina one can make the correct diagnosis and institute the appropriate treatment directed more towards the psychic centre than to the heart itself.

In short, all these functional cardiac disorders occur in a highly neurotic and sensitive person with great fear of a likelihood of his getting heart attacks at a future date. This fear is very often the result of tremendous emotional immaturity with excessive need for love and protection. These patients usually

have excessive anxiety about their own health and also about that of their family members. They show a complete lack of confidence in themselves and hence any sudden and severe stress can cause the development of any of the above stated functional cardiac disorders. These patients often complain of fatigue and exhaustion after working for a short while and thereafter they become easily irritable and excited. All these features can be collectively labeled as neurasthenia features which make these patients more susceptible to get various cardiac neurotic conditions. Once they develop one of these conditions a vicious circle is formed resulting in anxiety followed by further aggravation of their clinical features referable to any one of the functional cardiac disorders. As already discussed, mere symptomatic treatment directed towards the heart, such as vasodilators, betablockers or digoxin will not

Table 4.

Table shows a comparative value of Neurohumoral changes before and after the *Shavasana* type of Yoga Therapy and Diazepam Therapy for six months for functional cardiac disorders
(Cardiac Neurosis)
(Singh, R.H., Dubey, G.P. and Udupa, K.N.)
(To be published)

Neurohumor	YOGA THERAPY		DIAZEPAM THERAPY	
	Before treatment	After treatment	Before treatment	After treatment
Plasma Catecholamine (ng/Ml)	236.42 ± 33.48	196.00 ± 18.30 0.05	254.25 ± 58.12	182.5 ± 13.57 0.05
Urinary VMA (Mg/24 hrs.)	4.21 ± 0.90	2.67 ± 0.52 0.001	3.67 ± 0.68	2.37 ± 0.40 0.01
Plasma Cortisol (Ug%)	33.19 ± 7.32	22.53 ± 5.44 0.01	34.87 ± 4.86	21.05 ± 2.50 0.001
Urinary Hydroxy Corticoids (Mg/Gm Creatinine)	10.51 ± 2.27	9.16 ± 1.1 N.S.	12.55 ± 2.92	8.75 ± 2.03 0.01

relieve these patients for a period unless they are also treated for their associated psychological disturbances simultaneously. Hence a detailed psychic history of all these patients should be taken and appropriate psychotherapy should be instituted. In addition various tranquillizing measures already discussed elsewhere should be used freely to get over the vicious circle phenomenon origninating in the hypothalamus and limbic system. The use of these drugs helps greatly to tide over the acute situation. However, for a prolonged use they should not be recommended since they are likely to become less effective and hence there is a tendency to take them in higher dosage leading to the development of drug addiction. Hence we advise yogic exercises and breath control for younger people and meditation for older people with satisfactory and lasting relief. All those who resort to Yoga gradually develop self-confidence in themselves to tide over the acute situation and then they gradually become free from all anxiety conditions usually leading to satisfactory and lasting cure (Table-4). Hence all these measures must be started together by the patients in order to get complete cure.

CHAPTER 17

Bronchial Asthma

This is a common condition in which a person gets attacks of difficulty in breathing. He feels greater difficulty in expiration than in inspiration. The condition is usually associated with feeling of tightness in the chest, cough and audible wheezing. In between the attacks, the patient may remain normal or near normal. The duration of attack may vary from a few minutes to a few hours, but sometimes it may last for days. Usually such attacks come at night and may remain for a variable period of time.

There are three main causes which may excite the onset of the disease, namely (*a*) infection of the respiratory passages, (*b*) respiratory allergy to certain specific allergens and (*c*) psychophysiologic reactions to stressful life situations. Even amongst the three, stressful situations seem to be the most important factor which predispose a person to the development of this disease. Hence this factor needs special consideration.

It is observed that hypersensitivity that is seen in these patients is partly hereditary and partly acquired. This hypersensitivity is not limited to the mucous membrane of the air passages alone, but also involves the entire central nervous system which on stimulation releases excess of acetylcholine. The patients are hypersensitive not only to the various chemical substances in the environment as was often postulated, but also to specific human beings in the environment. Therefore, many times the attacks of asthma come as a result of conflict between the person and his environment to which he is unable to react externally by fight or flight reactions due to various social reasons. This certainly leads to excess liberation of acetylcholine from CNS which produces the sensitized bron-

chial musculature to go into a state of severe tonic contraction and bronchial secretions leading to the development of asthmatic attacks.

This hypersensitive personality is partly a hereditary trait and partly acquired and such personality traits can be seen in many psychosomatic disorders. Groen, a pioneer worker in the field, has described the neurotic "Core" of asthmatic patients as follows:

1. Marked ego-centric personality.
2. A tendency towards impulsive behaviour.
3. A diminished capacity for adaptation to unfavourable life situations.
4. A tendency towards developing a dominating personality.
5. A greater emotional hypersensitivity.
6. A greater demand for love and affection.
7. Stubbornness which may lead to conflict with the key figures in the social environment.
8. Strong reactions of jealousy and rivalry which make these patients somewhat unpopular.
9. Refusal to solve inter-personal conflicts by "talking it over" or by adopting give-and-take policy.
10. A disturbed psycho-sexual development: men often becoming sexually inhibited and women frigid.

All these personality traits can be seen clearly in most of these patients, some of whom are in almost constant conflict with their environment. Hence, many of these asthmatic patients become not only medical failures but also social failures. But in others these traits may not be so conspicuous and one can get to know them only when one subjects them to a detailed study. Further, in many of these patients a change of environment produces a dramatic beneficial effect. Although there may be many explanations, it appears that mainly it is due to shifting to an environment which is free from interhuman stressful situations.

Another evidence to support the psychogenic origin of asthma is that a well planned psychotherapy has been shown to

be beneficial in many cases of asthma. Thus, a daily practice of relaxation postures together with breath control exercises has been shown to cure quite a number of asthmatic patients. It seems that allergy and infective condition only act as exciting factors on a person who is susceptible to such attacks due to a specific personality trait and a hostile human environment.

In all such cases with a feeling of frustration resulting from the action of a dominant pesonality, the autonomic nervous system becomes activated, especially the parasympathetic nerves. Thus, the susceptible organ, the tracheobronchial tree in these patients which had become sensitive partly as a result of hereditary factors and partly due to various environmental factors since birth, becomes the target of various physiopathological changes. At first, as a result of excess of acetylcholine stimulation without the concurrent rise of catecholamine, there occurs a spasmatic contraction of smooth muscles of the bronchi. This leads to constriction of bronchi and especially the bronchioles causing airway obstruction. Thus, bronchial mucous membrane becomes congested which leads to excessive secretion of mucus which accumulates in the tracheobronchial tree. Thus, the bronchial spasm accompanied by mucus collection in the tracheobronchial tree causes the expiratory wheezing in these cases. This swollen mucous membrane patched with excess of mucus collection in the entire tracheobronchial tree is more sensitive to bacterial infection and hence the process of infection becomes readily added to the entire complexity of the problems. From these facts one can see that though psychological stress is the main cause for initiating this disease, its further development and perpetuation mostly rest with the development of allergic phenomenon and also the superadded periodical infection. Therefore, we should recognize these facts in the early stage of the disease and adopt appropriate preventive and curative measures for a lasting relief.

Treatment

Since it is now well established that asthma is a psychoso-

matic disease, all the preventive and curative measures must have a psychosomatic basis. Mere investigation of allergic or infective phenomenon by the body-oriented medical men or the study of psychic stress by the psychiatrists will not solve the problem of these patients. To give a lasting relief, it needs an integrated interdisciplinary approach for improvement in the treatment of these patients.

With regard to the prevention, one should be able to detect the early signs of this condition in the childhood period. Thereafter, one should institute preventive measures both from the bodily and psychological point of view. Mere testing of allergic phenomenon and its treatment will not serve the purpose. Simultaneously with this, one will have to make psychological and behavioural approach also, to prevent this condition from the very beginning. If the child is young in age, even psychotherapy of the mother would give the required benefit to the child. Such a psychotherapy should include relaxation therapy, Yoga or meditation. A regular practice of any of these measures would certainly prevent or delay the onset of this disease if it is adopted from the very childhood. In addition, various physical factors, such as obstructed air passages, recurrent respiratory infections, excessive tobacco smoking or excessive air pollution by industrial gases are some of the factors which may predispose the onset of this condition in susceptible persons. Therefore, they must be properly looked into and various preventive steps should be taken to overcome these problems. Thus, while establishing any new industry, people in authority should be told that proper disposal of industrial gas must be ensured, so that it does not cause menace to the people. It is always wiser to combine human health and happiness with presperity rather than a bit of prosperity prevailing at the cost of human wellbeing.

Another factor which may predispose the development of this disease is excéssive tobacco smoking from the very young age. Needless to say that it produces chronic irritation of the bronchial mucosa leading to spasm and infection repeatedly. Therefore, efforts should be made to reduce the use of tobacco in all such susceptible persons with a particular type of psychic

personality. Even here the regular practice of meditation might reduce the requirement of tobacco as was shown by Shaffi and others.

CURATIVE TREATMENT

In the acute stage of the disease there is no alternative but to institute the appropriate medical measures to tide over the situation. Since most of the medical treatment of this condition is symptomatic, the following measures are found useful: 1. Bronchodilators, viz. Isoprenaline inhalation or injection of Adrenaline 0.3 to 1cc subcutaneously give prompt relief. Similarly Aminophylline by mouth or by intravenous injection 0.5 gm in 5% glucose solution also helps immediately. 2. If these fail, the administration of corticosteroids greatly facilitates tiding over the acute situation. Similarly judicious use of antibiotics and expectorants helps them to reduce the infection and also to clear the air passages. 3. Change of environment, elimination of contact with allergens and psychotherapy may also help considerably to overcome the acute phase of the disease.

In addition to these medical measures, a well conceived Yoga therapy has been found to be of much use in most of these cases not only in preventing the attacks, but also in reducing the severity of the attacks. Whereas it may be difficult to say at present whether this therapy can completely cure this disease, one can certainly say with confidence that this type of therapy greatly helps to reduce the severity of the condition if it is resorted to at a relatively early stage.

In our practice, we give Yoga therapy both in the form of 8 postural exercises (*Asanas* –Appendix) and breathing exercises (*Pranayama*) everyday. In all we had given this treatment to patients of bronchial asthma of either sex belonging to the age group of 15 to 40 years. These 8 postural exercises are of vigorous type and hence the patients had to get the full training at our Centre for a few days. Thereafter, they continued these exercises at their homes and they periodically reported to us for a follow-up examination. All these patients were originally examined, investigated and treated in our chest Clinic. When

HISTAMINASE AND HISTAMINE IN CASES OF BRONCHIAL ASTHMA IN DIFFERENT CONDITIONS

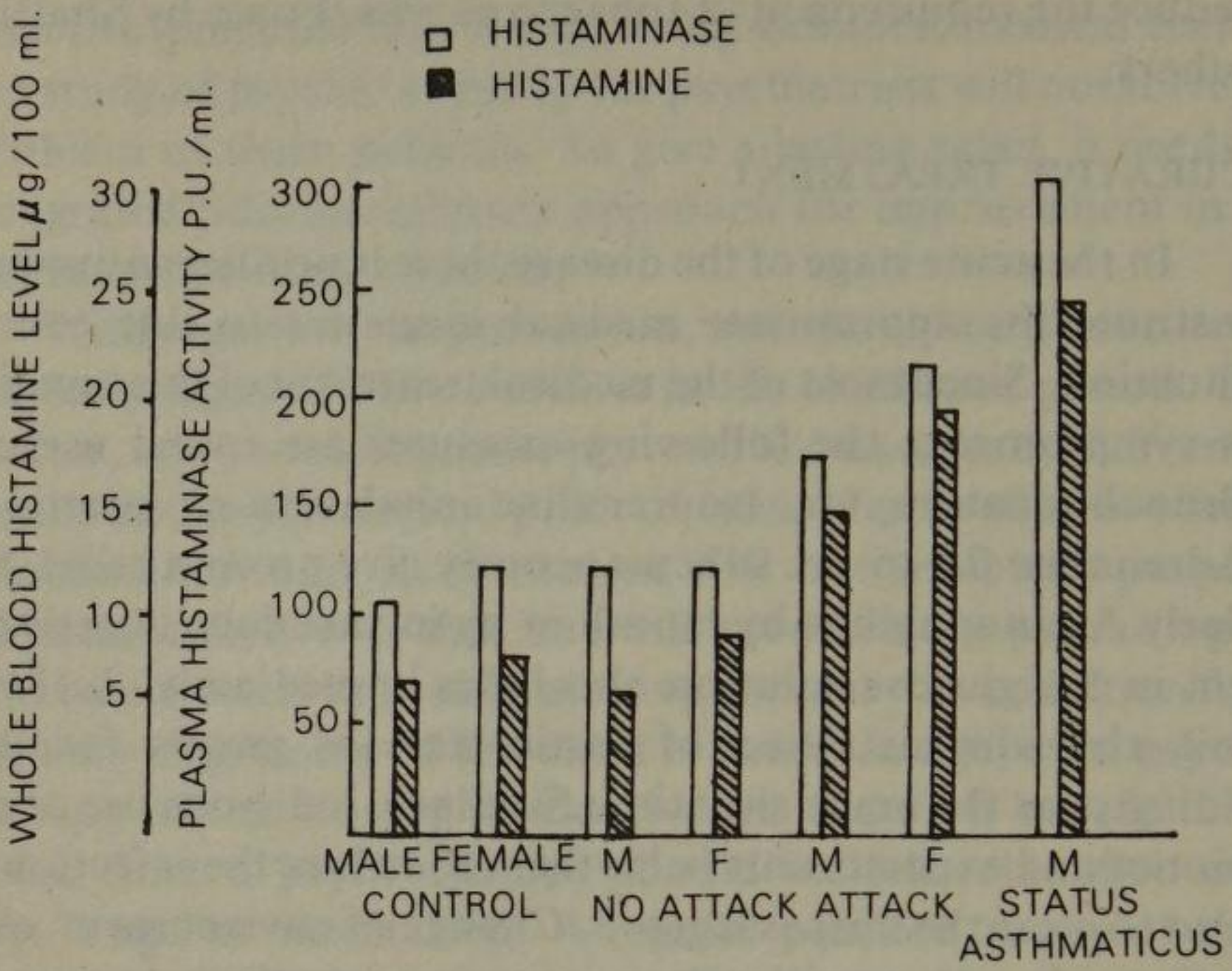


Fig. 54. Shows the levels of histamine and histaminase in bronchial asthma cases. When the patient is not under attack their level remains within normal limits. During the attacks their levels go high and in status asthmaticus their levels go to the highest peak.

the results of modern treatment were found unsatisfactory, they were referred to Yoga Clinic for getting the necessary treatment. In the Yoga Clinic, in addition to the recording of changes in clinical status of the patients before and after yogic exercise, changes in the excretion pattern of neurohumours in the urine were also investigated. Amongst the neurohumors, urinary excretion of choline which would roughly indicate the acetylcholine turnover and the urinary excretion of adrenaline and noradrenaline indicating the turnover of catecholamine were studied in these cases. Our preliminary investigations of these patients clearly indicated that these patients had a marked increase in the formation and excretion of acetylcholine and histamine (Fig. 54, 55) and a comparatively reduced activity of adrenaline, noradrenaline and cortisol (Table-5). We could then fully give a biochemical explanation of the physiopathology of this condition. It is suggested that bron-

PATTERN OF BLOOD HISTAMINE LEVEL IN DIFFERENT STRESS DISORDERS

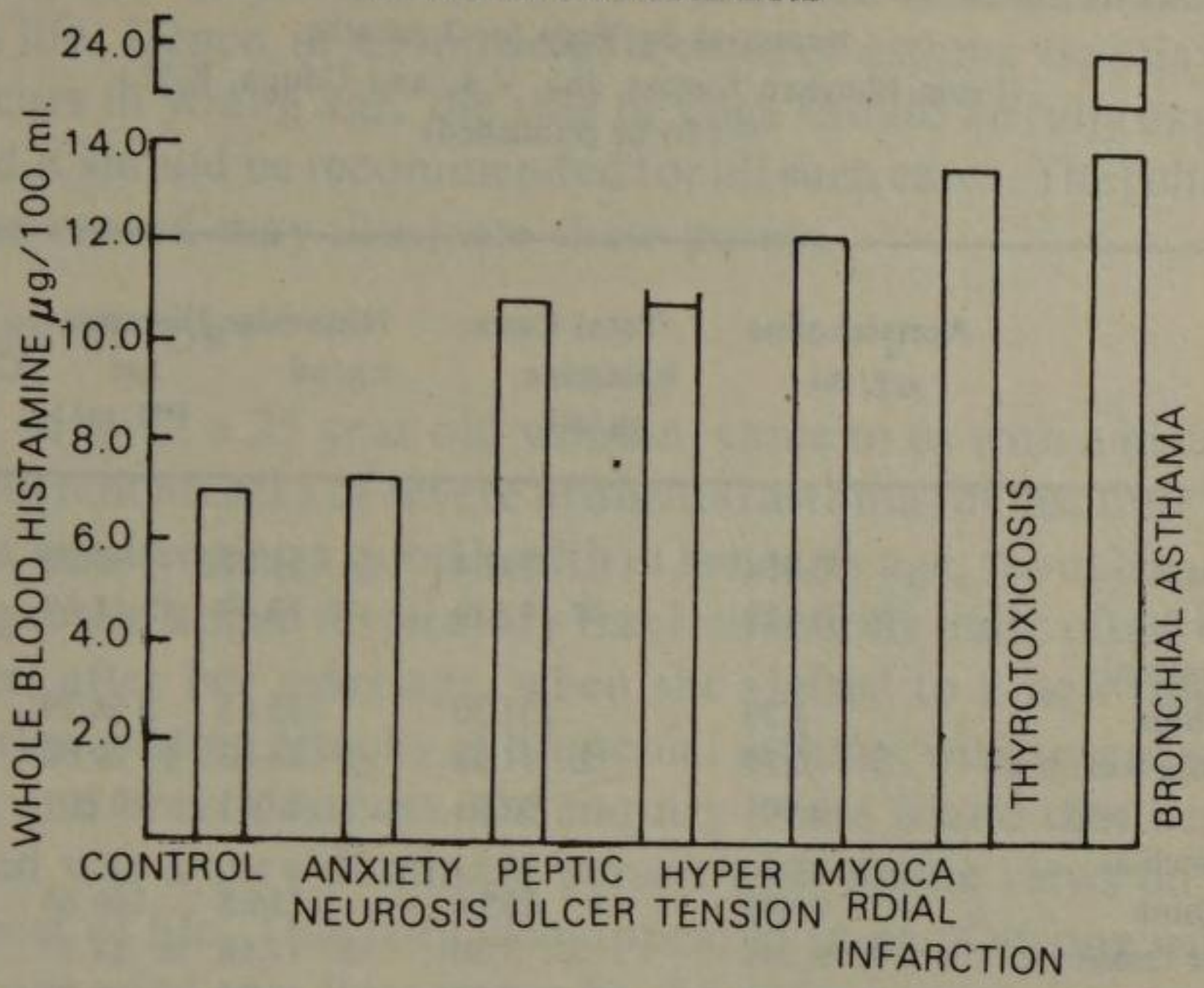


Fig. 55. Shows the pattern of blood histamine levels in different stress diseases. Our studies reveal that the patients with one of the common allergic conditions such as Bronchial Asthma have the maximum rise of histamine level in the blood especially during the attacks.

chial constriction results from excessive formation of acetylcholine or, deficiency of catecholamines and cortisol (these patients become unable to overcome the action of acetylcholine) or, it may be due to both the above factors operating simultaneously in these cases. Recently, reports have also appeared which indicate that there is also a deficiency of urinary excretion of cyclic AMP in these cases, thus further reducing the activity of adrenaline.

Hence, the treatment of this condition with adrenaline or cortisone is nothing but a physiological replacement therapy just as we give insulin in cases of diabetes mellitus. So far, this was not emphasized enough and hence this needs further study as to whether this condition is primarily due to parasympathetic nerve predominance or due to sympathetic nerve deficiency or due to both. The replacement therapy with these neurohumors will have to be planned accordingly.

Table 5.

Shows Neurohumors and Plasma Cortisol in Bronchial Asthma before and after treatment by Yoga for 3 months.

(From Bhushan Kumar, Jha, V.K. and Udupa, K.N.)

(To be published)

	Acetylcholine μg/ml	Total Catecholamine ng/ml	Histamine ng/ml	Histaminase PU/ml	Plasma Cortisol
Control (15)	0.714 ± 0.128	242.4 ± 7.519	51.27 ± 12.49	90.20 ± 14.69	21.12 ± 3.91
Bronchial Asthma before treatment (40)	1.29 ± 0.39 0.001	251.30 ± 11.88 0.001	135.65 ± 46.03 0.001	158.79 ± 29.60 0.001	13.43 ± 8.27 0.001
Bronchial Asthma after treatment (5)	0.949 ± 0.249 0.01	255.6 ± 7.80 0.05	116.8 ± 13.68 0.05	146.66 ± 24.17 0.01	15.43 ± 2.95 0.001

What surprised us still more was that when we made these patients undergo the practice of yogic exercises, they gradually got the feeling of physical and mental well-being followed by reduction in the severity of attacks, and reduction in the requirement of drugs like aminophylline or cortisone. In most of the cases, the improvement was sustained, though somewhat slower than one usually expects to get. As one observes the improvement clinically one also finds the biochemical changes for the betterment. Thus, gradually the choline content becomes less and the urinary adrenaline, noradrenaline and 17-hydroxy-corticoids contents improve and reach the normal level. From these observations, one can say that yogic and breathing exercises given to these patients are physiological procedures without the aid of any drug which fully correct the biochemical deficiencies and bring them towards normal level. As a result one can notice a gradual improvement in the clinical condition of these patients. Hence, once the improvement is attained it can be maintained throughout the period of one's life, provided he is prepared to continue such yogic exercises.

In fact, yogic exercises would keep the person young and active and he is likely to get many other benefits of Yoga throughout his life. Hence, in all intractable cases of asthma especially if it occurs in young age, the role of Yoga should be fully explored and it should be recommended for all such cases. The following case record may illustrate these points.

CASE REPORT

Mrs. C, a 25 year old woman, came to us with a history of recurrent attacks of severe bronchial asthma for last four years. She was keeping a good health in her early age, though she used to get the upper respiratory tract infections quite often. However, after her marriage, when she shifted to a new town she started getting attacks of bronchial asthma, with severe wheezing and breathlessness. On enquiry it was found that her husband was a very dominant person with strong views on every aspect of life. This lady also appeared to be of strong will, she always tried to adjust to her husband by suppressing her own views. From her history it became obvious that this suppressed emotional distress probably played an important role in causing attacks of bronchial asthma.

In the beginning attacks used to come for a short duration, and used to be relieved by aminophylline. But gradually as the time passed, her attacks became more frequent and lasted for a longer period. At this period even the medicines did not give her adequate relief. At the time of her visit to our Clinic, even heavy doses of cortisone would relieve her only for a short period. On examination she was found to be a typical case of bronchial asthma with marked wheezing throughout the chest. Various investigations did not contribute much to our management. The allergic test to various agents also did not reveal any specific material to which she was allergic. Hence we decided to put her on a course of yogic practice as a trial measure. We thought this would help her much in view of the fact that there was a hidden yet strong psychological conflict between herself and her husband in various matters of life. However, she could not express them openly in view of the social customs and systems prevailing in the family.

She was put on the usual eight yogic exercises and also on the breathing exercises daily. To our great satisfaction, the frequency of the attacks gradually became less and so did the requirement of the medicines. Gradually in six months, her attacks were very few and lasted for a short period. Within a year her health improved considerably, so much so that she conceived a baby which she did not have for the preceding five year of her married life. However, during the later part of her pregnancy, she had to stop the yogic exercise and this soon resulted in recurrence of attacks of asthma. In spite of giving all the patent drugs it did not give her enough relief. After the delivery of the baby however, when she started doing yogic exercise the severity of the attacks of asthma became much less and she is carrying on with her life extremely well.

From this case one should be able to realize that yogic exercise will be of immense help to those patients who have strong psychological reasons for the development of the disease. In others with strong background of allergy or infection it may not work so spectacularly as it would work in the first group. Further, yogic practice would work well in the early case of such diseases in young people with no definite pathological lesions in the tracheobronchial tree. Once the disease has produced irreversible damage to the tissues, yogic practice would not be able to restore it back to normalcy. Hence, it should be resorted to at an early stage. In fact, we have observed that if those persons who are the likely or susceptible candidate for the development of asthma start practicing Yoga from the very beginning, they can completely prevent the development of this disease. One should also remember that the effect of yogic exercises remains in the body only for 24 hours. Hence they have to be practiced regularly at least once a day.

Further, one should remember that mere meditative type of yogic practice will not be of much value and so we have to recommend Hatha Yoga type of practice viz. eight standard yogic postures and exercise of breath holding(*Pranayama*), because we have already found that in this disease there is

BIOCHEMICAL CHANGES IN BRONCHIAL ASTHMA BEFORE AND AFTER YOGA

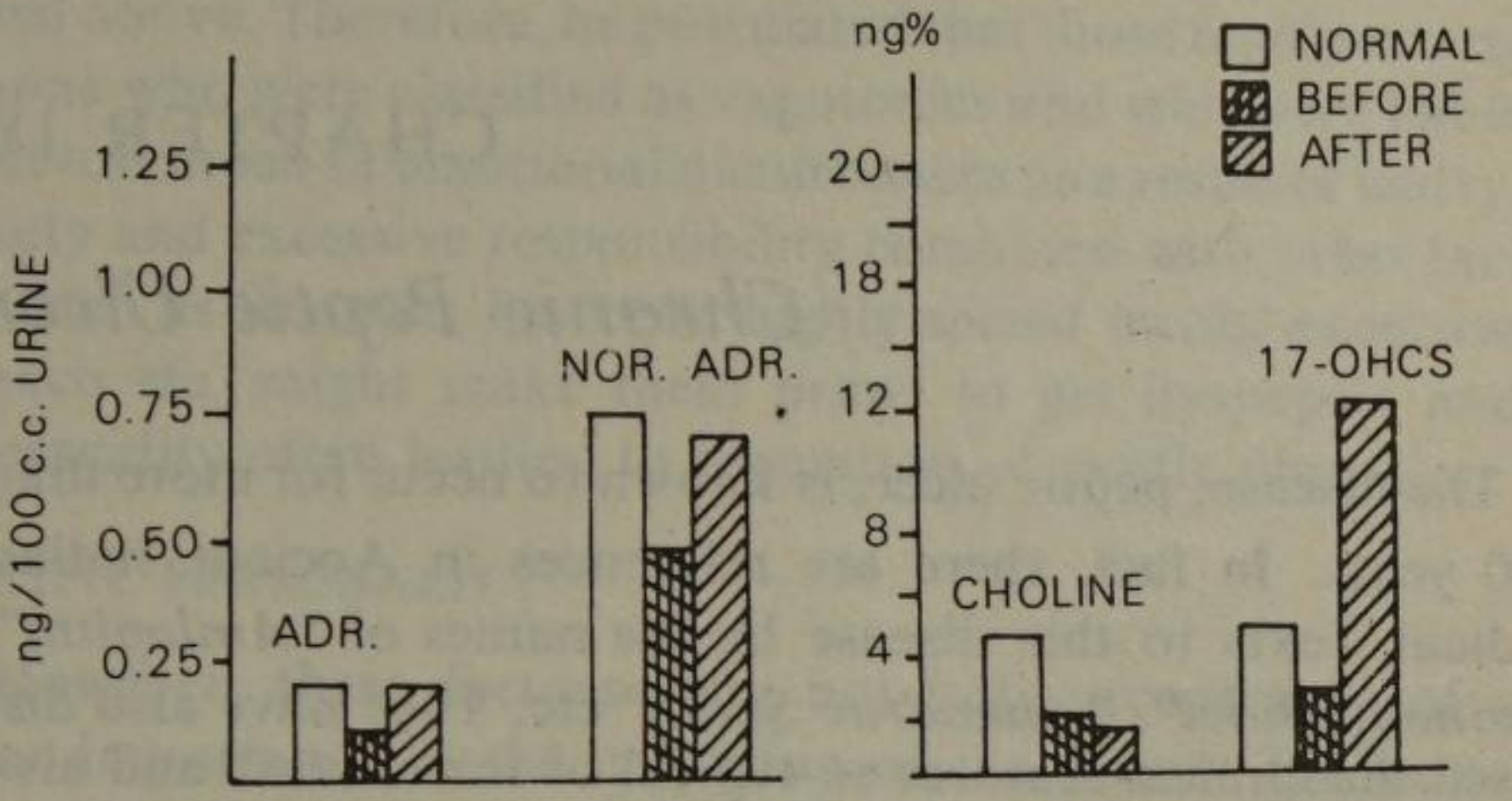


Fig. 56. Shows significant decrease of urinary adrenaline, noradrenaline, choline and 17-hydroxy-corticoids in cases of bronchial asthma in comparison to control subjects. After practice of yogic exercises for three months all these biochemical disturbances could be normalized to a considerable extent.

excess of acetylcholine and deficiency of catecholamines. This can be reversed towards normalcy by the Hatha Yoga practices, which induce reduction of acetylcholine and increase of catecholamine (Fig. 56). From that point of view Hatha Yoga practices in case of bronchial asthma seem to be ideal physiological method of treatment involving no harmful effect of potent drugs and with no cost to the patient. Hence, it is strongly suggested that more and more physicians should adopt such non-medicinal procedures, for giving a lasting relief to these patients sufferring from such a debilitating disease as bronchial asthma. However, in acute attacks, the modern medical procedures have to be adopted.

CHAPTER 18

Chronic Peptic Ulcer

The disease, peptic ulcer, is known to occur for more than 2500 years. In fact, there are references in Ancient Indian Medical Texts to this disease by the names of "*Amlapitta*", "*Parinam Shool*", "*Annadrav Shool*" etc. They have also discussed the clinical features so typical of this disease and also advised various treatments. Some of these topics will be discussed later in appropriate context. Suffice to say here that this disease was well known to our ancients and they had discussed this condition at length.

In modern times, various theories regarding the etiology of this condition were put forward by several earlier workers. Amongst them the neurogenic theory received considerable attention. Talmo almost a century ago put forward the neurogenic theory for peptic ulcer formation. Clinically he observed that the patients of peptic ulcer were in great nervous tension, and therefore he postulated that an intense vagal activity as a result of these tensions, may be responsible for causing these ulcers. In order to prove this, he carried out his experiments in rabbits and observed that electrical stimulation of the vagus nerve increased the secretion of gastric juice. In addition, he also observed tonic contraction of the stomach musculature with closure of pylorus and in some animals shallow ulceration in the stomach mucosa. From these experimental and clinical observations one could say that the vagus nerve played an importnat role in the causation of peptic ulcer. In the beginning of this century, Cushing observed gastric ulcer in patients with brain injury or tumour in the hypothalamic region. He felt that these ulcers were not due to only peripheral action of the vagus nerve, but also due to central stimulation of the hypothalamic

region from the psychic centre of brain which ultimately led to various changes in the stomach mucosa and musculature mentioned above. Therefore, he postulated that those highly strung persons who were classified as vagotonics and who were liable to get too much of emotional disturbances as a result of worry, anxiety and excessive responsibility combined with other factors such as frequent intake of highly spiced meals, excessive tobacco etc. might make them prone to get dyspepsia and hyperacidity often leading to formation of peptic ulcers.

SPECIFIC PERSONALITY

However, these factors were not fully accepted as of a major importance in the causation of the disease till recent years, when Alexander and Groen put forward a new hypothesis of the psychogenic nature of these peptic ulcers. They felt that psychic tension in a patient plays an important role in the causation of peptic ulcer. Further, Alexander also observed that not only they have a specific type of psychic tension, but also have a specific personality trait. Such persons usually have a strong urge to receive gratification by their hard work and are usually very sincere and dutiful. Such people readily become frustrated usually if they did not receive the appreciation which is due from their colleagues or superiors.

Similarly, they also become very much disappointed since neither they are susccessful in their chosen profession, nor they get any appreciation from the society for the service they are rendering to the people. However, such persons do not usually tell their difficulties or disappoinments to any one like their friends, close colleagues, parents or mariage partners. They usually keep these frustrating problems to themselves only as a result of an inborn habit of exaggerated self-control. This makes them brood over their frustrating problems all the time leading to increased mental tension and the development of one of the psychosomatic disorders like peptic ulcer in due course of time. Thus, these individuals carry with them a specific personality which makes them more vulnerable and sensitive to get this stress disorder whenever they are exposed

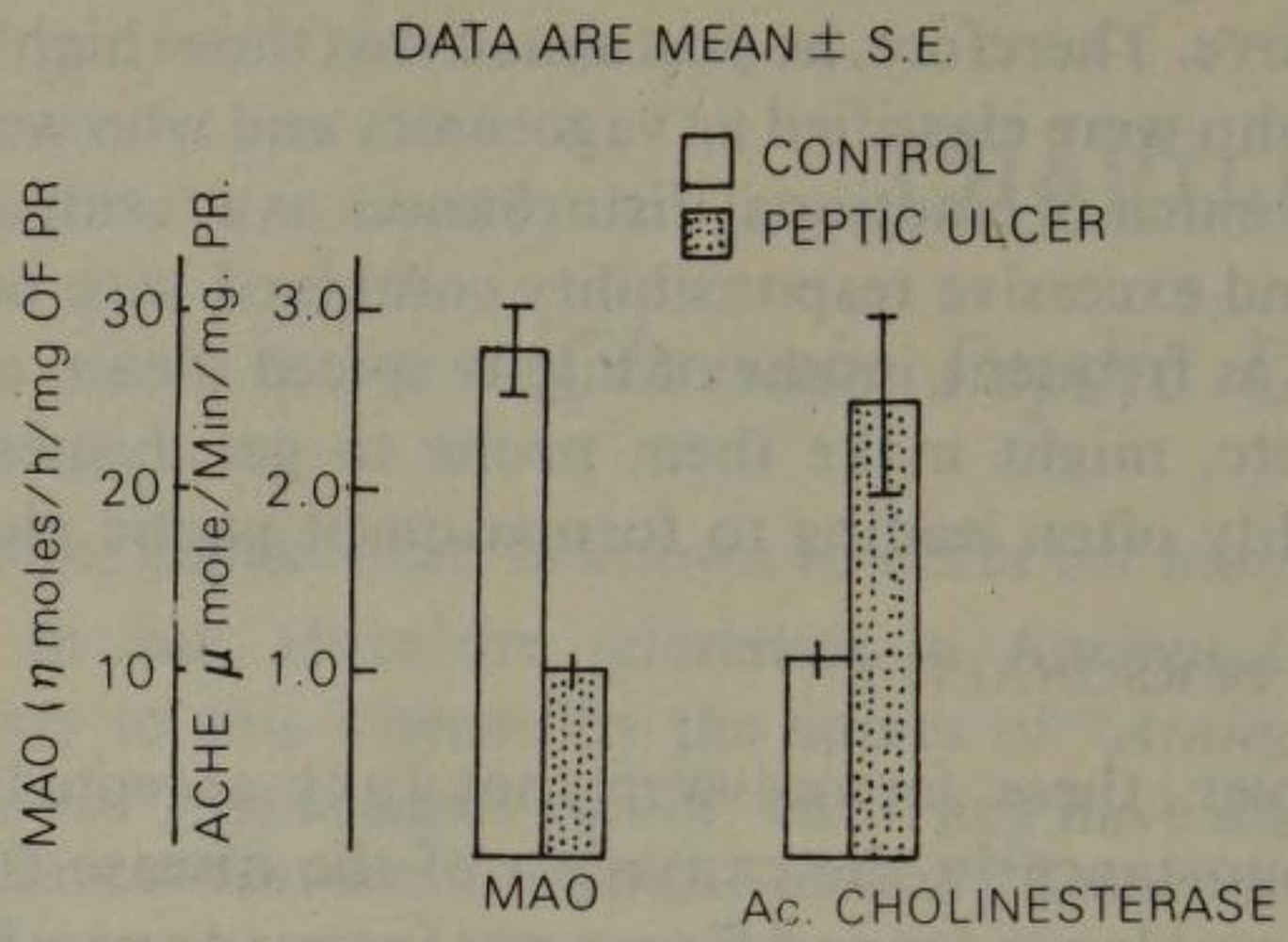


Fig. 57. Shows the neurohumoral metabolizing enzymes MAO and cholinesterase in the platelets which indicate genetic susceptibility of neurohumoral action. Note that in peptic ulcer patients, there is less quantity of MAO, and more of cholinesterase indicating greater turnover of acetylcholine which may predispose them to get Peptic ulcer.

to some difficult and conflicting situation in society. Such specific personality structure of an individual is genetically determined and cannot be changed (Fig. 57). But one can certainly influence those factors which one acquires after birth. Amongst them the conflicting human situation is one of the important factors which cause this disease and hence such a situation will have to be avoided. Groen states: "In this respect peptic ulcer is the result of a 'double level' interhuman conflict. If an individual is frustrated either in his family or in work situation no ulcer will develop; because the social gratification in one field of communication may compensate the frustration in the other. Ulcers arise only in individuals who are frustrated both in their strivings for attention and love reception in their family and in their efforts to obtain social success and gratification in their work". It is clear from this that one is liable to get peptic ulcer if he is considered as a failure in his work situation and if he has frustration and disappointments in the family circumstances.

EXPERIMENTAL STUDIES

In the experimental animals also Selye observed that following acute stress of trauma, infection or emotional disturbance there occurred adrenal hypertrophy, acute atrophy of the thymolymphatic tissues and gastroduodenal ulcers. Selye called all these changes part of general adaptation syndrome which consisted of three stages, viz. (*a*) alarm reaction, (*b*) phase of resistance, and (*c*) phase of exhaustion. According to Hume, all these changes are the result of continuous stimulation from the cerebral cortex, especially from the psychic centre, limbic system, hypothalamo-hypophyseal system, and other neuroendocrinal organs. Even in these various systems, the hypothalamo-hypophyseal system and the adrenocortical mechanism play an important role in causing all these changes seen in chronic stress leading to ulcer formation in the stomach or duodenum. Several Russian workers could also produce experimental neurosis after giving repeated psychic stress leading to severe anxiety states in animals which at first produced functional disturbances in the organs and finally caused peptic ulcer or other stress disorders like hypertension etc. Similarly if the rats are completely immobilised by restraining all their movements, then also one can see the acute superficial ulcers in the gastric mucosa. The number of ulcers increased with the duration of immobilistion. These ulcer were considered to be due to severe psychological stress given all of a sudden. Thus in 24 hours 89% of the animals developed such ulcers. These ulcers healed rapidly when the immobilization experiments were terminated and after 5 days no ulcer could be seen in the nucosa. From these investigations one can conclude that these psychogenic gastric ulers are due to vascular, nervous and neuroendocrine factors. In such cases, the acute psychogenic stress causes sudden excitation of sympathetic nerves leading to outpouring of catecholamines which causes marked vasoconstriction of the gastric mucosa. If such an ischaemic state is continued for quite some time, superficial ulcers develop promptly in the mucosa of the stomach. However, if the stress is continued for a longer period the outpouring of adrenocorti-

cal hormones also help to perpetuate the ulcers in the gastric mucosa. They possibly produce this effect by increasing the acid peptic secretion and also by reducing the formation of mucus in gastric mucosa. However, all these aspects will be dealt with later on. Suffice it to say here that the acute psychogenic stress can easily produce acute ulcers in the stomach and duodenum within a very short time which can continue to remain there so long as such acute stressful situation continues. However, if such a situation becomes chronic, these experimental subjects may develop the state of adaptation leading to the healing of these ulcers in due course. However, if the adaptation mechanism fails either due to excess of stress or due to exhaustion of adaptation process, the chronic duodenal ulcer may become the sequelae of these chronic stressful states.

CLINICAL OBSERVATIONS

Wolf and Wolff also observed on a patient with gastric fistula that whenever there was an excessive emotional stress there occurred ulcerations in the mucosa of the stomach. These ulcers used to disappear subsequently when this patient went into a state of relaxation. This clinical observation on a living patient clearly indicates that disturbed emotions occurring repeatedly may cause chronic peptic ulcer in susceptible patients. How such changes in emotions can cause stomach ulcers was further studied experimentally and clinically. By stimulating the various centres of midbrain, especially in the hypothalamic region in the experimental animals one can observe hyperaemic changes in the upper gastrointestinal tract, erosion and ulceration in the stomach mucosa. Similarly, as already mentioned, Harvey Cushing also observed perforated gastric or duodenal ulcer in patients who had successfully undergone operation on the hypothalamic region of brain. It is postulated that emotional changes occurring in the hypothalamic region cause the lesion in the organs such as stomach through the autonomic nervous system. As can be expected, such a dysfunction of autonomic nervous system can be divided into that of the sympathetic and that of the parasympa-

thetic. Thus, in excessively predisposed persons with predominance of sympathetic nervous system, essential hypertension and cardiovascular disorders are commonly seen. Persons with predominance of parasympathetic nervous system are more liable to get lesions like peptic ulcer, ulcerative colitis or bronchial asthma.

Here one should also note the types of persons that are likely to get such psychosomatic disorder. Usually they are those who inhibit their outward reactions to stimuli. Normally, if one is attacked physically or mentally one becomes openly angry and shouts at the attacker. If however, such a situation is not followed by outward and visible reactions a chronic emotional tension develops in such a person which would ultimately lead to the development of psychosomatic disorder. Thus the less active is the external emotional manifestation, the more it causes the inner disturbance in the function of autonomic nervous system. Such a chronic functional derangement of the autonomic nervous system leads to the development of psychosomatic symptoms in the first instance followed by actual manifestations of the disease.

There has been much discussion as to why some persons exposed to stress develop peptic ulcer whereas a few others develop ulcerative colitis and still others develop bronchial asthma. Some workers feel that specific emotional disturbances are responsible for causing specific organic lesions in the same way as specific micro-organisms are for causing diseases in a specific organs. Thus the parasympathetic nerves are involved in the body building programme through the anabolic process. The sympathetic nervous system, on the other hand, prepares the person to face the emergency situation demanding fight or flight. Therefore, it stimulates cardiac activity, increases blood pressure and inhibits the anabolic process of the gastrointestinal tract. Therefore the development of a particular type of psychosomatic disease in a given person depends upon his genetically based psychosomatic constitution and also the type of external environmental stressful stimuli. Thus if a person is required to face a stressful situation, but he tries to

escape from it with one excuse or the other, or tries to take the shelter of his relatives or friends, then he is more likely to develop disorders of parasympathetic nervous system, provided his psychosomatic constitution is also congenial to such a development. Such persons are likely to develop peptic ulcer, ulcerative colitis or bronchial asthma. Others who are prepared to face the stressful situations themselves and constantly work within themselves for such a situation, yet due to inhibition or repression of aggressive impulses do not fight, develop excessive sympathetic activity causing some of the functional disorders of the heart, high blood pressure, tension, headache etc.

Hence, the causation of a particular type of disease in an organ of a given individual depends upon his psychosomatic personality type and the type of environmental stress. Here one should remember while planning the therapy for such patients that the genetically based body constitution is a permanent feature of a given individual. But the stressful environmental factors can always be changed by taking various psychotherapeutic and other similar measures.

STRESS AND STOMACH

Whenever there is an excess of stress, there is increased secretion of hydrochloric acid and pepsin in the stomach. This is due to the action of the psychic centre of the cerebral cortex which stimulates hypothalamus via limbic system. In hypothalamus, the anterior part activates the vagus nerve which in turn stimulates stomach to increase all its activities as it is a motor nerve both for the muscles and secretory glands. In addition, the posterior part of hypothalamus stimulates the anterior pituitary gland to produce more of ACTH which helps to put out excess of adreno-cortical hormones. Both ACTH and cortisone also cause excess of acid gastric secretion and reduce the secretion of mucus. It is the combination of all these factors which ultimately leads to the formation of ulcers in the first part of the duodenum (Fig. 58).

In order to prove the above facts a large number of experi-

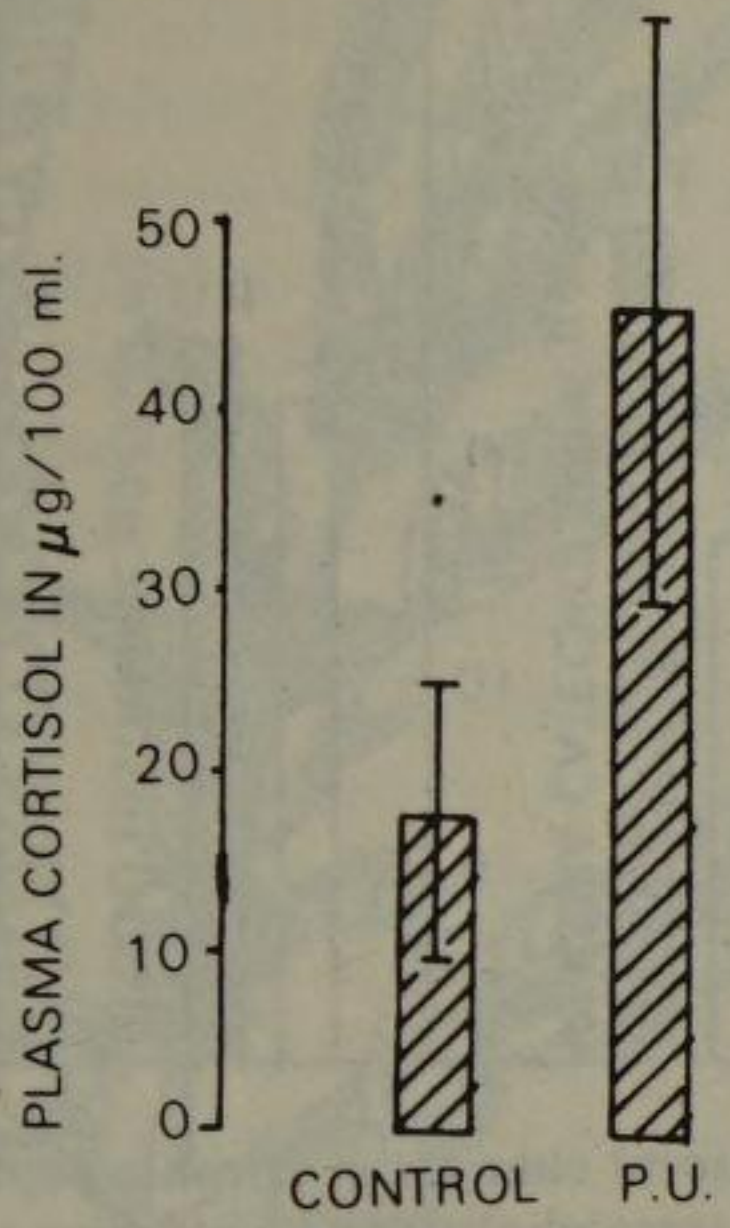


Fig. 58. Shows plasma cortisol level in peptic ulcer patients. Note the high plasma cortisol level in these patients indicating that chronic psychological stress plays an important role in the persistence of ulcers in these cases.

mental and clinical methods have been devised especially with a view to find out effective methods of management. It is now well established that the major neurohumoral disturbance that occurs in peptic ulcer is acetylcholine, which is liberated in excess quantity at the nerve endings of both the vagi nerves as a result of stimulation from the centres in hypothalamus which is directly under the control of the psychic centre of cerebral cortex. But thereafter the neurohumoral changes that occur in stomach differ from acute stress ulcers of the stomach seen after burns (curling ulcer) to those of chronic peptic ulcer. In acute ulcers the sudden release of excessive quantity of acetylcholine leads to outpouring of all the other major neurohumors such as catecholamine, histamine and serotonin. Even amongst these three catecholamine plays a dominant role leading to severe vasoconstriction, multiple focal necrosis, and acute ulcer formation in the stomach. These ulcers will gradually heal spontaneously as the excessive neurohumoral response subsides.

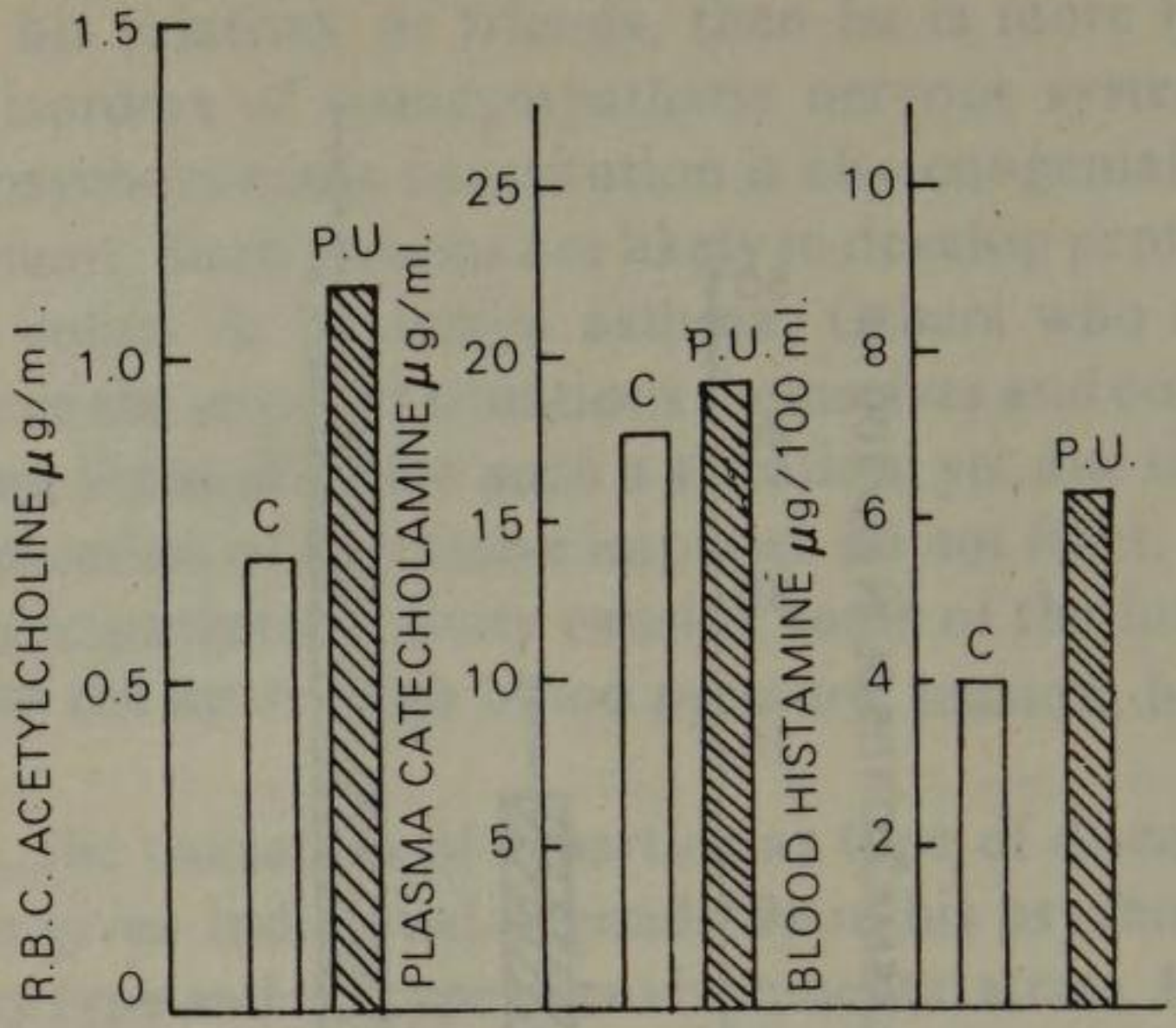


Fig. 59. Shows neurohumoral changes in chronic peptic ulcer. Note significant increase in the RBC acetylcholine and histamine contents in these cases with almost no change in the catecholamine level. This shows increased activity of the parasympathetic nerves in these cases.

However, in cases of chronic peptic ulcer, because of the chronic recurrent stressful situations, associated with genetic and environmental susceptibility of a given person, there is a prolonged and sustained acetylcholine response throughout the period. Because of this powerful parasympathetic predominance in these cases, the sympathetic nervous system remains dormant and hence there is a low level of catecholamines and their synthesising enzymes such as DBH (Dopamine B. Hydroxylase) and the degrading enzyme MAO (Monoamine Oxidase) both in the blood and stomach tissues. Similarly, the level of serotonin (5 Hydroxy tryptamine) also remains low leading to dysfunction of gastrointestinal canal. However, another important neurohumoral disturbance seen in this condition is the high content of histamine and histaminase both in blood and also in the stomach tissue. Thus, it is this high acetylcholine and histamine level which is responsible for the prolonged and excessive secretion of acid gastric juice resulting in the maintenance of chronic ulcers in stomach or duodenum (Fig. 59).

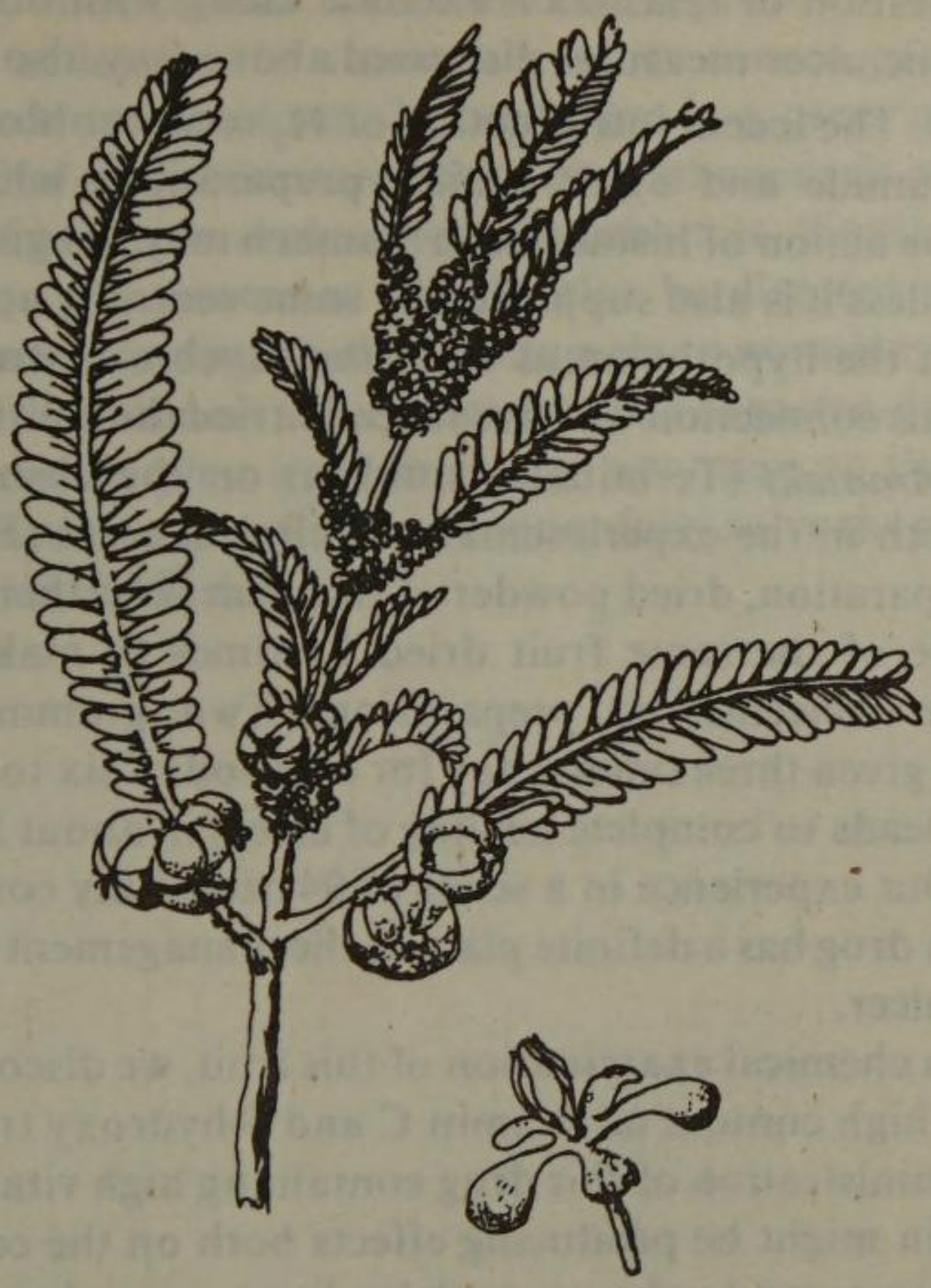


Fig. 60. Shows the picture of the herb "Amalaki".

MANAGEMENT

Unless one understands this basic neurohumoral disturbance, which in fact has neurogenic basis, one cannot really strike upon the correct method of management. Therefore, the mere treatment with antacids to overcome the excess acid secretion in this condition will not be of much avail, unless the disturbance in the psychic and hypothalamic centres is also restored to normalcy. Recent introduction of tranquillizers such as diazepam which has a specification on the hypothalamus greatly helps these patients to overcome their trouble along with antacids and other similar agents. Those measures which restore the psychic centre disturbances to normalcy such

as meditation or relaxation exercise along with other known antipeptic ulcer measures discussed above may also help these patients. The recent introduction of H_2 receptor blockers such as metiamide and other similar preparations which would block the action of histamine in stomach may not give a lasting relief unless it is also supported by some centrally acting drugs either at the hypothalamus or at the psychic centre level.

In this connection we have recently tried the fruits of a plant called *Amalaki* (Terminalia amblica) on the chronic peptic ulcer both in the experimental and clinical cases (Fig. 60). In this preparation, dried powder of this fruit is further coated by the juice of the same fruit dried 21 times to make it as an effective concentrated preparation. Two gramme of this powder given three times a day for a period of six to ten weeks usually leads to complete healing of ulcers in about 80% of the cases. Our experience in a series of 94 cases fully convinced us that this drug has a definite place in the management of chronic peptic ulcer.

On a chemical examination of this fruit, we discovered that it has a high content of vitamin C and 5-hydroxy tryptamine. The administration of this drug containing high vitamin C and serotonin might be producing effects both on the central nervous system and on the stomach leading to complete healing of ulcers. The high content of vitamin C in it may be an additional value for the management of these ulcer cases. Recently, Sanyal and his colleagues used another indigenous preparation called "Banana Powder" in these peptic ulcer cases with equally good results. On a chemical examination of banana powder, it was found that it contained a high quantity of serotonin. Thus, it can be said now that the administration of serotonin containing plant products might be having a very beneficial response in the treatment of peptic ulcer which acts both on the central nervous system as well as on the stomach. From these recent studies, it becomes clear that neurohumors play important roles in the causation of chronic peptic ulcer and therefore for their effective management the disturbed neurohumors will have to be brought to normalcy by giving

appropriate medications. Mere use of drugs which will have only local action in the stomach mucosa cannot produce a lasting effect on the ulcers. Hence, there is a great need for reappraisal of our understanding of the pathogenesis of peptic ulcer based on the neurohumoral disturbances. Similarly, our approach to the treatment should also be directed towards bringing down the disturbed neurohumors to normalcy both at the level of central nervous system and also at gastro-duodenal level. Unless we plan and direct our attention to the entire psychosomatic constitution, we cannot fully solve the problem of this common disease.

CHAPTER 19

Ulcerative Colitis

Ulcerative colitis is a very serious disease of the colon which usually occurs after some specific emotional conflict. It can develop in various forms from mild to severe, depending upon the personality and body constitution of the individuals. It is also dependent upon the vulnerability of the colon as a result of certain environmental factors like dietetic imbalance leading to recurrent episodes of diarrhoea or constipation. In the mild form it may develop as irritable colon, and in moderately severe form it may develop as mucus colitis.

There had always been some dispute as to whether emotional disturbances directly produce the disease or they are only one of the precipitating factors for the onset of this disease occurring as a result of some other specific agent. From all the available data and also from our own experience, we are convinced that this disease is caused by intense psychological trauma. Groen put forward the following in support of this hypothesis.

(1) The personality of the patient is such as would always expose him or her to emotional conflict with some "key person" in his or her environment e.g. parents, brothers or sisters, teachers, employers, colleagues or neighbours. We had seen a patient aged 25, in an enlightened family, who was always criticised and humiliated for his minor deficiencies by the parents in the presence of all including his newly wed wife. This situation became so intolerable that he ultimately became a victim of serious type of mucus colitis. All the usual antidysenteric treatments failed to give him any relief. Ultimately he was given a yogic postural treatment (to be discussed later) with complete recovery within 3 months of the commencement of

the treatment. This further confirms that these diseases fall in the group of psychosomatic disorders.

(2) It is also observed that in acute cases, the disease breaks out within 24 to 48 hours after sustaining emotional conflict as a result of humiliation or defeat in the presence of others. Sometimes this humiliation or threat of humiliation occurs as a result of exposure of feeling of inferiority of the individual in his or her function as male or female. We had seen a young, intelligent, and highly sensitive boy whose marriage was fixed to a healthy, wealthy and hefty girl. Every time the date of his marriage was fixed, he would get an attack of severe ulcerative colitis 48 hours before the date. This episode was repeated three times as a result of which his marriage was ultimately cancelled. Here the main precipitating factor for the onset of ulcerative colitis was the intense feeling of apprehension and inadequacy in every respect, due to which he used to get severe nervous breakdown leading to the development of ulcerative colitis.

(3) In these patients, such a humiliation or defeat is not at all manifest or visible to an outside observer. Such inhibition of outward behavioural discharge converts the external emotional trauma into internal conflict situation. It is this emotinal conflict within the individual which ultimately produces intensive psychological and neurohumoral changes leading to severe ulceration in the mucosa of colon. As will be discussed later, the intense vasoconstriction of the colonic mucosa as a result of increased secretion of noradrenaline is possibly responsible for the development of acute ulceration in these stressful situations.

Personality Factors

In this regard Wolf states: "The relationship of colonic hyperfunction in 19 patients with ulcerative colitis. The subjects were found to be characteristically outwardly calm, superficially peaceful and more than usually dependent. Beneath the calm exterior it became apparent that there was intense hostility, resentment and guilt. Such feelings, when sustained and

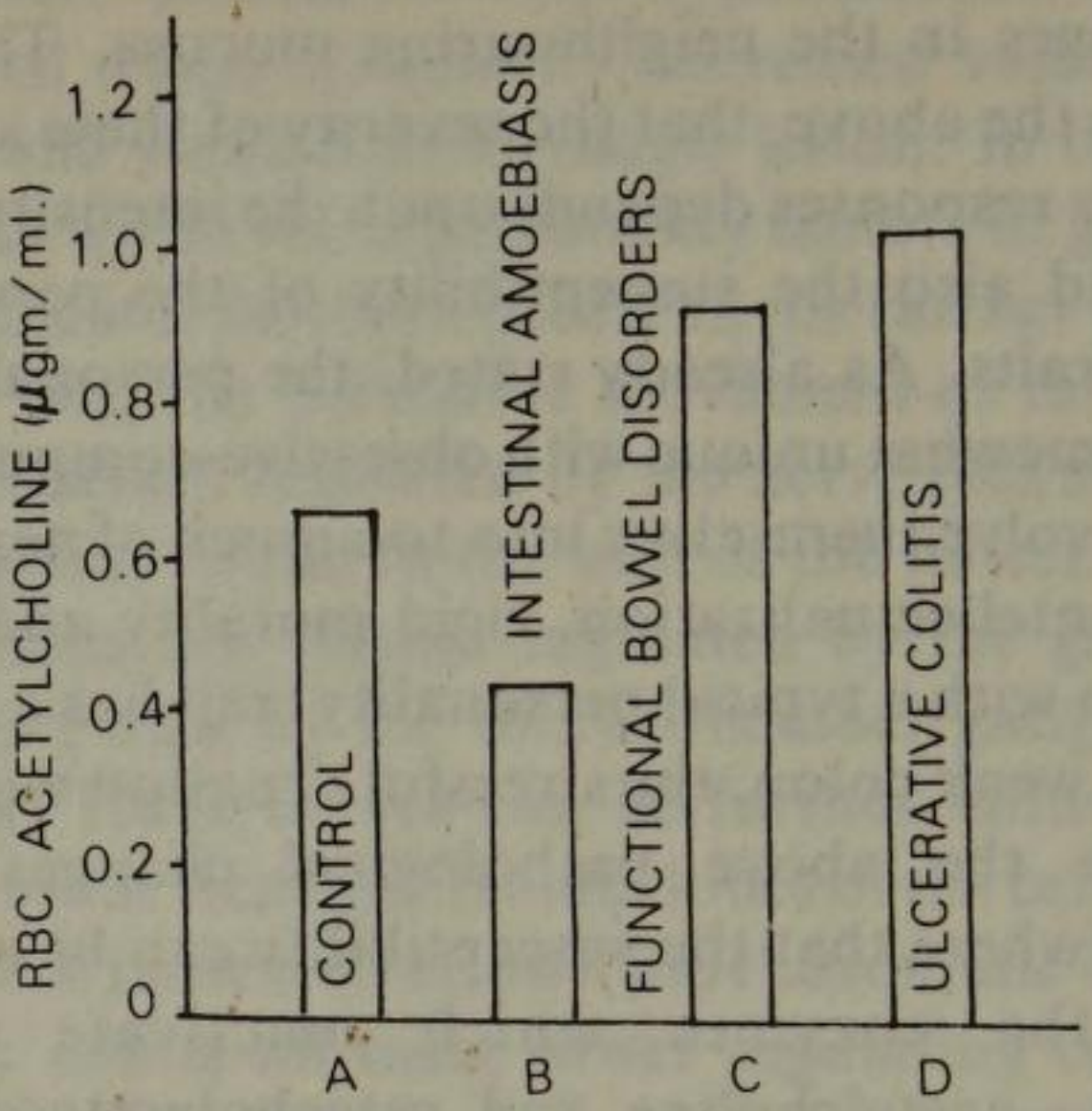
unrelieved were associated with hyperfunction of the colon with increased transport activity, increased vascular activity, turgescence and small haemorrhagic lesion. In these patients the manner in which these personality factors of genetic origin and environmental factors operate needs further explanation. It is known that the peristaltic movement of the colon is an autonomic function regulated by the nerve plexuses of Auirbach and Meissner found in the wall of the bowel. These autonomic functions are further regulated by the ganglia in the mesentery and also by the thoracohember gangli of sympathetic nerves. These nerves can be further influenced by the spinal cord, brain stem and frontal lobes of the cerebral cortex. It seems that in these well known psychosomatic diseases such as ulcerative colitis all these lower regulating centres in the sympathetic and brain stem regions are superseded by psychic centres of the frontal lobe which ultimately exercise their dominating influence on the colon leading to the above stated microcirculatory changes in the mucosa of the colon.

All these stressful situations at first produce intense hyperactivity of the cerebral cortex leading to excessive outpouring of acetylcholine. This is soon followed by the sympathetic response leading to excessive liberation of catecholamines such as adrenaline and noradrenaline. These changes produce vasoconstriction at the arteriolar and venous level leading to pooling of bloods in the capillaries of the mucosa. Because of the poor circulation in the mucosa with vasoconstriction the mucosa may slough off and stress ulcers may form. This will ultimately lead to profuse haemorrhagic and mucus discharge from the colonic mucosa and ulcers. This is soon followed by absorption of the mucosal cellular materials into the lymphatic channels which act as an antigen to produce antibodies in the regional mesenteric lymph nodes. These antibodies, when released from the lymph node, reach the colonic mucosa via blood stream. There occurs an antigen-antibody reaction of the autoimmmune type leading to the development of chronic inflammatory process with marked lymphocytic inflitration. Such an inflammatory process not only perpetuates and

enlarges the ulceration process, but also causes severe inflammatory changes in the neighbouring mucosa. Thus one can surmise from the above, that the severity of these autoimmune inflammatory responses depends upon the intensity of stressful situations and also the susceptibility of the person and his personality traits. As already stated, the personality of these patients is somewhat unique with obsessive-compulsive behaviour. They involve themselves into too much of neatness, indecision, over-intellectualization, rigid morality and anxiety. If such a person with a typical personality trait has a susceptible, sensitive and weak colon, the stressful situation would affect it and produce the above pathological changes. We have observed elsewhere that the susceptibility can be measured by estimating the enzymes which inactivate the major neurohumors—acetylcholine and catecholamines, namely cholinesterases and mono-amine oxidase. By measuring these enzymes in the blood initially and later on in the platelets we have been able to label which type of persons are likely to develop what type of stress disorder. If such susceptible persons are exposed to various environmental factors such as faulty diet and nutrition, their colonic mucosa is likely to be taxed more than any other organ in the body. Therefore, in severe stressful situations, it is their colon which is likely to be affected with stress disorders in view of their susceptibility and also that of the organ concerned. These are some of the hypotheses we have put forward on the basis of our clinical and laboratory observations. However, they need further confirmation.

However, once the disease is fully established, it also influences the patient's personality. The patient becomes more dependent on others when he or she falls a victim to frequent attacks of diarrhoea, anaemia, dehydration, abdominal pain and an alarming loss of blood in the stools. Because of this the patients are unable to adapt themselves to this serious illness and hence they are likely to become more neurotic. However one should remember that a disease alone cannot make one so neurotic. In fact by nature and from the very beginning of one's

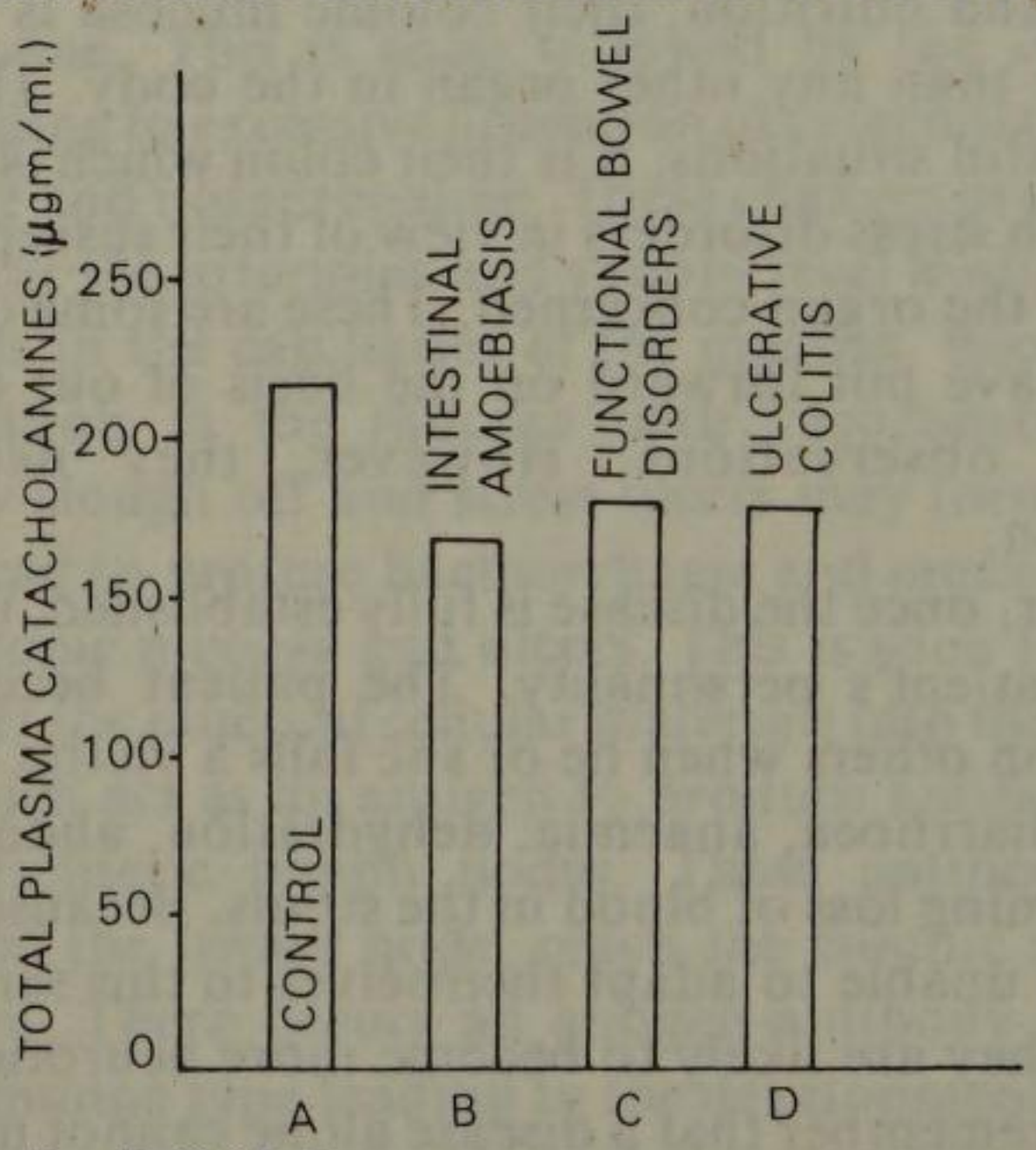
MEAN RBC ACETYLCHOLINE IN COLITIS



AVS B—P<0.05 SIGNIFICANT
AVS C—P<0.05 SIGNIFICANT
AVS D—P<0.01 SIGNIFICANT

Fig. 61. Shows the levels of acetylcholine in different types of colitis cases. It is found raised in both functional bowel disorders and ulcerative colitis indicating their neurogenic origin.

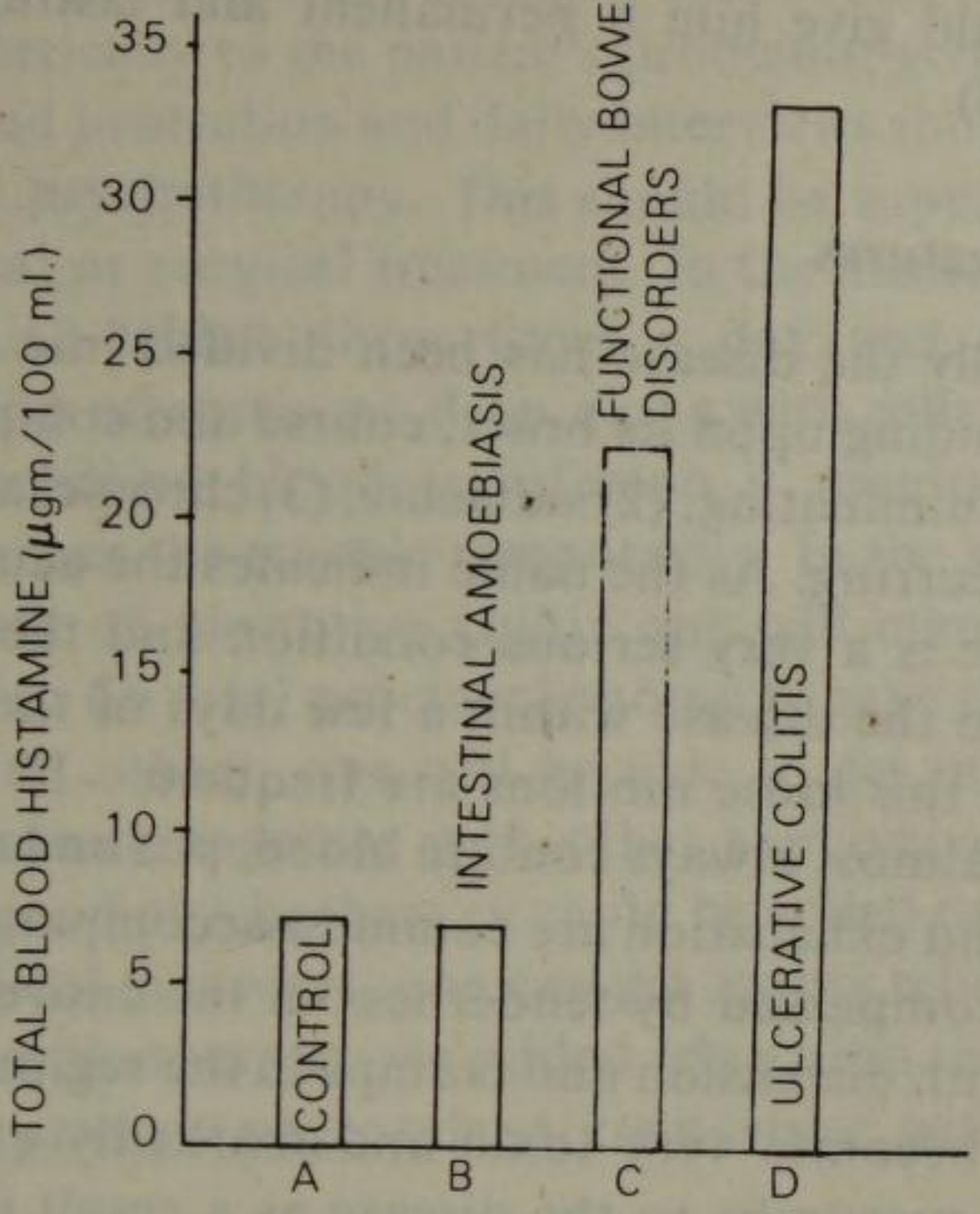
MEAN PLASMA CATECHOLAMINES IN COLITIS



AVS B—P<0.05 SIGNIFICANT
AVS C—P>0.05 INSIGNIFICANT
AVS D—P<0.05 SIGNIFICANT

Fig. 62. Shows Plasma catecholamine studies in colitis cases indicating no rise of this neuorhumor. In fact, there is a slight lowering of catecholamine in these cases.

MEAN TOTAL BLOOD HISTAMINE IN COLITIS



AVS B—P>0.05 INSIGNIFICANT
AVS C—P<0.01 SIGNIFICANT
AVS D—P<0.001 SIGNIFICANT

Fig. 63. Shows a significant rise of Histamine in the functional bowel syndrome and a marked rise in ulcerative colitis cases. It is possibly the hypersensitive reaction that is responsible for producting such a severe inflammatory response in the colonic mucosa.

life one often develops specific personality traits which on receipt of a certain type of stress makes them victims of this disease. Once this starts, it further aggravates the situation and makes the person more neurotic and dependent on others. From this it is quite clear that the original psychic personality of the individual influenced by various environmental factors, such as nutrition, dietetic habits, etc. makes him susceptible to this disease. However, the exciting cause seems to be a severe stressful situation which involves the release of the neurohumor acetylcholine from the brain, and marked stimulation of parasympathetic nerves especially those supplying the colon and rectum. This leads to severe local reactions in the colon leading to excessive liberation of histamine causing severe inflammations and ulcerations. Therefore, unless we take the totality of this psychosomatic disease as a whole in a neurotic

individual, we will not be able to plan any effective treatment which would give him a permanent and lasting cure (Figs. 61,62 & 63).

Clinical Features

Clinically the disease has been divided into four distinct types depending upon its onset, course and complications: (1) acute and fulminating, (2) subacute, (3) chronic, and (4) relapsing and recurring. As the name indicates the acute and fulminating type is a very serious condition and the patient may succumb to the disease within a few days of the onset of the disease. In this loose motions are frequent—15 to 30 times a day. They almost always contain blood, pus and mucus. Fever, anaemia and exhaustion are common accompanying features. This is accompanied by tenderness in the entire colonic area together with distension and cramps in the region. The patient gradually becomes very toxic and markedly exhausted and ultimately succumbs to the disease as a result of irreversible endotoxin shock.

The subacute, chronic and relapsing types of colitis also have a similar manifestation but less severe and slow in progress. It usually affects young and middle aged persons of either sex with periodical remissions and exacerbations depending upon the stressful situation. The patient is exposed to life situations periodically. In spite of all these evidences psychological aspects of these patients have been given scant attention and most of the investigators have emphasized the microbiological and pathological point of view with very little success. Therefore, there is urgent need for studying these patients from the psychosomatic angle in order to understand the etiology, pathology and preventive aspects of these conditions.

Management

In all the treatments psychotherapy should play an important role in the management of these patients. Further it was

observed that if the life situations of these patients are changed there may be spontaneous remission of the symptoms. Listening sympathetically to the patient's problems, giving him constant care and protection and daily interviews should be made parts of the psychotherapy. This should be supplemented by usual medical or surgical treatment. In the medical measures Solizoparin, 2 tablets three times a day and intracolonic administration of cortisone drop along with other supportive measures including blood transfusion if required will help them to get over the trouble temporarily. In the acute, fulminating variety of ulcerative colitis one will many a time be called upon to do total proctacolectomy to save the life of the patient. In all others, one will be able to get relief through medical measures together with other supportive regime. If, however, a good psychotherapy could be added to these surgical and medical measures, one can get lasting relief. Recently, instead of psychotherapy, we added relaxation therapy in the form of *Shavasana* a yogic relaxation posture, with impressive response.

CASE REPORT

Mr. B., a 50 year old businessman, had been having attacks of loose motions along with mucus and blood for the past 3 years. These attacks had made him completely incapacitated and weak. He started having such attacks after facing some acute conflicts between himself and his business partners. When we saw him, he was weak and anaemic and all our investigations including radiological studies confirmed the diagnosis of ulcerative colitis of chronic relapsing type. We gave him some psychotherapy, medical measures and supportive therapy including two blood transfusions. There was some improvement, but not complete relief. Then we subjected him to relaxation type of Yoga therapy in the form of *Shavasana* for 30 minutes every morning and evening. He carried on this treatment very regularly for one month with remarkable improvement. Since then we have been following him up for the last 2 years with no evidence of recurrence of any com-

plaints. He has put on his original weight and started doing his business work as usual. However, he is continuing with yogic postures every morning and evening, which according to him keeps his body and mind in perfect order.

From this one can say that in all these cases in the acute phase one will have to give proper medical and surgical tretment as required, to tide over the situation. However, in order to get lasting relief, one will have to resort to some type of therapy such as yogic postures or meditation which would have a tranquillizing effect on the brain. Unless this is added no lasting relief is possible. Since this is a psychosomatic disease, with the main seat of lesion in the frontal lobes of the cerebral cortex, one will have to control this site of lesion with effective measures like Yoga therapy so that further episode could be prevented. So far this aspect of tretment has not been taken into consideration and hence the recurrent episode of the disease leading to enormous miseries of these patients could not be prevented. Since the psychosomatic etiology and pathogenesis are now becoming clear it is high time that a newer approach of management is made to give lasting relief to the patient.

Mucus Colitis

It is a condition in which there is pain in the colonic region, defecation disturbances and passage of stool often mixed up with mucus. The defecation disturbances may be constipation with passage of small pellets of stool frequently or it may even be diarrhoea. This condition is also known as irritable colon syndrome, colonic neurosis or spastic colitis.

It is a common condition associated with certain psychic features such as anxiety, nervousness and irritability. It is seen both in men and women in the age group of 15 to 45 years. Commonly it manifests itself as constipation and pain in the left lower quadrant which is often relieved after pasage of stool. In more severe cases, excruciating pain, diarrhoeal stools, accompanied by passage of profuse quantity of mucus and

other systemic disturbances are seen. Such severe cases often show features of psychoneurosis also. They often swallow air and this leads to gaseous distension of the abdomen and flatulence. Because of this, these patients become much disturbed about their digestive system as a whole.

The examination reveals that they are usually men of a frail constitution. They show many neurotic manifestations and yet they otherwise look normal. The abdomen looks somewhat distended and on palpation, a tender sigmoid colon filled with faeces can be observed. Their rectum usually remains empty and proctoscopic examination does not reveal anything except some quantity of mucus.

Thus from their history and physical examination, intermittent characteristics of the disability occurring in association with emotioal distress, one can arrive at the correct diagnosis. However, it would be safer if various laboratory and radiological investigations are carried out in doubtful cases in order to exclude amoebic dysentery, divertienlitis and also neoplastic lesion.

TREATMENT

Since the whole disease has a psychoneurotic basis, the usual medicinal treatment without psychotherapeutic measures would give only temporary relief, if any. If the disease is not controlled by proper measures, it may even lead to ulcerative colitis or malignant lesions. Therefore, proper evaluation of the patient's psychological problems and appropriate psychotherapeutic procedures must be instituted to overcome his recurrent troubles. A good reassurance and change of environment might help him to overcome his stressful situations. Symptomatic medical measures such as periodical warm saline enema and a daily intake of the husk of 'Isopgol' at night might help the patient to overcome the symptom of constipation. The frequent intake of antispasmodic drugs should be avoided to prevent the development of drug addiction. It would be interesting to know that in the past one year, we have been advising these patients the practice of yogic exercises (Hatha Yoga) with

remarkable success. In all we have treated 8 cases and all of them recovered completely from this disease within a period of six months or so.

CASE REPORT

Mr. P.P. aged 24, gave a history of recurrent attack of pain in the left iliac fossa for the past 3 years. Such an attack is usually associated with passage of loose motions containing a lot of mucus. It all started soon after his marriage, which apparently was not a very happy one. The wife was too dominating and assertive. Other members of the family also joined hands with his wife in criticising his activities. This completely isolated him from his family making him a victim of frustration and other emotional disturbances.

Soon he started developing recurrent attacks of pain in abdomen with passage of loose mucus containing stools. This attracted a lot of sympathy for him from everyone including his wife. However, the moment he was all right again, the old situation isolating him from others reappeared. Therefore, he started getting symptoms frequently to get some sympathy from his family members continuously.

On examination there was found a tenderness in the region of sigmoid colon which was palpable. Repeated stool examination did not reveal any abnormality. The proctoscopic and sigmoidoscopic examinations also did not reveal any abnormality except an increased congestion in the region. All the antidysenteric and antispasmodic drugs did not give him much relief. In fact, the intensity of pain continued to increase. Since all the medical measures failed, a possibility of instituting a surgical treatment on the basis of regional colitis was considered but postponed.

In the meantime, a detailed psychological history was prepared which indicated very stongly that it had a strong psychoneurotic basis. Hence, he was asked to practice eight common yogic postures everyday in the morning on empty stomach, followed by breathing exercises. This he started doing very regularly and to our utter surprise his symptoms gradually

subsided during the next two months and within 4 months they completely disappeared. We have been following this patient for the last 5 years and he has absolutely no such symptoms. In fact, he is leading a very comfortable family life but at the same time he also practices yogic postures regularly in the morning before he goes for work.

We obtained similar results in almost all cases and we are closely watching them for the recurrence of symptoms. From this it appears that mucus colitis is definitely a psychosomatic disorder which can be controlled effectively and permanently by such non-medical measures, as yogic practice. However, it should be remembered that it will have to be practiced regularly throughout one's life, if one wants to get a lasting relief.

CHAPTER 20

Thyrotoxicosis

Goitre, denoting an enlargement of the thyroid gland with different clinical features has been known for centuries. However, credit goes mainly to Graves, who in 1835 first described 4 cases of thyrotoxicosis, all of whom developed identical clinical manifestations with enlargement of the thyroid gland. They were middle aged ladies, who developed this condition with a previous history of receiving severe psychic trauma. This was followed by various toxic manifestations like palpitation, nervousness, rapid loss of weight, enlargement of the thyroid gland and protrusion of the eyes. The description of the clinical manifestations of Graves patients for the first time was so vivid that the disease was subsequently named after him. In 1840 Basedow on the basis of his further studies added many more clinical manifestations of this condition and hence in Germany and in many other European countries this condition was also known as Basedow's disease.

Thereafter extensive literature has appeared all over the world with regard to its clinical manifestations and management of this condition. In spite of all these studies there is no unanimity with regard to the pathogenesis of this condition. However, many of these workers have noted that the onset of this disease is preceded by the occurrence of some type of severe psychic trauma. But how this psychic trauma could cause the enlargement and hyperfunctioning of thyroid gland still remained a riddle.

As a result of this, some of the investigators in this field abandoned the idea that there was any relationship between psychic trauma and this disease. They felt that a patient's history of having emotional disturbances may be purely incid-

ental and it might not have anything to do with this disease. But a majority of the workers observed that they could get a definite history of sustaining severe psychic trauma in about 80 to 90% of the cases and hence they could not brush aside such an important event associated with the onset of the disease. Therefore, a search for establishing relationship between the psychic trauma and the onset of thyrotoxicosis continued throughout the later part of the last century and the early part of this century.

It was found by some observers at the beginning of this century that an injection of an extract of anterior pituitary could produce certain forms of hyperplasia of the thyroid gland and also exophthalmos in experimental animals. This led to the hypothesis that the hyperfunctioning of anterior pituitary gland might be the main cause of this condition. However, when the method for estimating TSH in the blood by radioimmunoassay became available it was found that the quantity of TSH in the blood was much less in thyrotoxic patients than in normal persons. This had completely upset the theory which had postulated that the mental shock might be influencing the anterior pituitary via the hypothalamus, which in turn stimulated the thyroid gland.

LATS (Long Acting Thyroid Stimulator)

In the meantime in 1956, Adams and Purves employing a new bioassay technique for estimating TSH made some interesting observations. They found that the serum of thyrotoxic patients contained a specific thyroid stimulating substance which differed from TSH principally in its greater duration of action. Hence, they labelled it 'long acting thyroid stimulator' (LATS). The specific bioassay technique for estimations of LATS was later on modified by McKenzie. It mainly consisted of testing in the mouse of radioiodine in the blood. If one gives TSH the maximum rise of radioiodine occurs within 2 hours, whereas if one uses injection of the serum of thyrotoxic patients the increase in the radioiodine content of mouse blood occurs betwen 8 and 16 hours.

However, when attempts were made to characterize this substance from the blood of thyrotoxic patients, it was found that it did not originate from the pituitary gland and in fact its chemical composition was quite different from TSH. It was actually found to be an antibody of IgG in nature and was possibly synthetized by lymphocytes. These observations raised the possibility that LATS is an auto-antibody directed against some microsomal fraction of the thyroid gland.

In spite of all these evidences it could not be completely established whether LATS is involved in the pathogenesis of thyrotoxicosis or it is found as a result of thyrotoxicosis. For, it was found positive in the experienced hands only in about 60% of the cases, whereas in other's hand it was found positive in only about 40% of the cases. However, when globulin fraction was concentrated, another 30% of the cases became positive. Further, it was observed that there was no correlation between the severity of the toxic symptoms and the antibody titre of the LATS. In many patients LATS remained positive for a prolonged period even though thyrotoxicosis symptoms subsisted. Therefore, there occurred a severe doubt with regard to the role of LATS in the pathogenesis of thyrotoxicosis. The only thing that still supported this theory was that if the LATS positive mother delivered a child, LATS could be demonstrated in the new bron infants for some time along with the clinical features of thyrotoxicosis. However, this would subside gradually as the LATS content decreased. Further, it was also found that LATS titre was more related to pretitial myxoedema and opthalmopathy rather than to symptoms of thyrotoxicosis. In addition, LATS was found in members of the families of thyrotoxicosis patients without having any toxic symptoms. This means that these persons might be carrying some inhibitor for LATS which could be responsible for their not having toxic symptoms as was postulated by Adams in recent years.

Several other workers, especially Chopra and his colleagues, found absolutely no relationship between the LATS and thyrotoxicosis in several groups of cases. Therefore, a serious doubt had been cast on the role of LATS in the patho-

genesis of thyrotoxicosis. In addition this theory does not take into account the background history, psychic trauma and clinical features of these cases and their relationship with the laboratory findings. Hence, even after extensive studies conducted by a large number of investigators the pathogenesis of thyrotoxicosis still remains obscure even after 140 years of its description.

Our Hypothesis

Therefore, we thought that this was a subject which needed a fresh and multidimensional approach free from any bias or commitment to the earlier theories of pathogenesis of thyrotoxicosis. On the basis of our clinical observations on more than 800 cases of thyrotoxicosis we prepared the following working hypothesis for conducting a detailed experimental and clinical investigation:

It was our finding that in almost all the observed cases some type of psychic trauma preceded the onset of this disease. Usually there is a variable amount of "interval" between getting such a shock and the onset of the disease, for which reason many a time the patients do not connect the insiduous onset of their disease with the mental shock. In view of this, unless one questions his patients closely and in sufficient detail one is liable to miss this important part of the history. Moreover it had been our experience that most of these patients are introverts. Therefore, they are hasitant to communicate everything to their physicians easily until they develop some type of confidence in them. This usually takes much time and sometimes more than one sitting becomes necessary to have a detailed history. After following such a procedure uniformly in all suspected cases of thyrotoxicosis, we have not found any case in which there was no psychic trauma initially to cause the onset of the disease. Of course, the nature and the severity of such psychic trauma were always found variable. Therefore, we were fully convinced from our clinical observations that the onset of the disease occurs as a result of receiving a sudden and severe psychic trauma as was also confirmed by a large number of earlier workers.

However, this does not explain why only a very few of such cases develop thyrotoxicosis, since every person in his life time is liable to get one or more such psychic trauma at one time or the other. Therefore, we will have to find out the reasons why only a few of them became victims of this condition. Possibly there may be some susceptibility in these persons to get this disease either due to some genetic factors or certain environmental causes. In this connection it is our hypothesis that there may be some enzymatic deficiency developing either congenitally or due to acquired conditions as a result of which the damaging effect of psychic trauma is not cleared away quickly from the thyroid gland and hence it becomes a victim of such a disease. In normal persons on the other hand such mental shock does not leave any trace of injury in the thyroid gland due to the presence of sufficient amount of neutralizing enzymes.

Neurohumoral Theories

It is a very well known fact the whenever there is a stress either due to physical or psychic injury there occur certain definite bodily changes as a result of stimulation of entire bodily systems. Amongst them, the nervous system responds more promptly than others and is followed by all other systems. Even amongst others changes in endocrinal functions leading to many metabolic changes occur first and are followed by other systemic changes in the cardiovascular, respiratory, digestive and genitourinary systems. All these changes promptly take place primarily to protect our body from the ravages of the injury and also to effect speedy recovery from the damages caused by the physical or mental trauma. Enormous amount of work has already been done in this field ever since Walter Cannon put forward the theory of liberation of adrenaline from the adrenal medulla to protect the body. Thereafter, Hans Salye extensively studied this problem and felt that the adrenocortical response as a result of stimulation of anterior pituitary, is the main response which would lead to all the other changes in the body. Moore and his colleagues

extensively studied this problem from the point of surgical trauma and his monumental work is too well known to be quoted here in detail. Thus, whereas endocrinal and metabolic responses following injury have been studied in sufficient detail, unfortunately, the changes in the neurohumoral pattern of our body as a result of stimulation of nervous sysem following injury, have not so far been dealt in sufficient detail by any of these investigators.

After the pioneering work of Walter Cannon in this field there were a few sporadic attempts to study this problem in experimental animals by giving various types of stress. In view of the lack of literature on the subject we postulated that in all such injuries the entire nervous system gets stimulated as a result of which the nerves pour out most of their neurohumors into their surroundings. These neurohumors are: (*a*) acetylcholine from the central nervous system and also from the parasympathetic nerve endings, (*b*) the catecholamines, both adrenaline and noradrenaline from the sympathetic nerve endings and also from adrenal medulla, and (*c*) in addition there can be liberation of histamine and possible seratonine (putative neurohumors) as a result of such generalized stimulation.

It is also now well established that all these neurohumors are quickly made inactive by the adequate liberation of different enzymes. Thus, the moment acetylcholine is liberated it is quickly destroyed by the action of the enzyme cholinesterases. Catecholamines are neutralized by monamineoxidase (MAO) and catecho-O-methyl transferase (COMT) produced locally. Similarly, histamine is neutralized by histaminase and serotinine is neutralized by the MAO. Thus, the body while responding to the sudden call given as a result of physical or mental trauma tries to overcome the damage by having many checks and counter-checks in the form of liberation of neurohumors and their respective neutralizing enzymes.

STRESS AND THYROID

In view of the above, we postulated that in those susceptible patients who have a sensitive thyroid gland, the liberation of

acetylcholine at the parasympathetic nerve endings (Vagus nerve) supplying the thyroid gland continuously as a result of severe psychic trauma may be the initial cause of starting the disease process. It is possible to conceive that whereas all other organs and systems might be having enough cholinesterases to neutrilize the liberated acetylcholine, the thyroid gland in this particular case may be unable to neutrilize the entire acetylcholine liberated at these parasympathetic nerve endings present in the gland. Thus, whenever there is a serious psychic trauma, there occurs hyperactivity of all the centres of the cerebral cortex, especially the psychic centre in the frontal lobe. From here the stimulation reaches the posterior part of the hypothalamus via the limbic system to activate the autonomic nervous system. Even here it is the parasympathetic nerve endings which liberate acetylcholine first throughout the body followed by the catecholamines which are liberated from the adrenal medulla as well as from the sympathetic nerve endings. We will later on discuss the role of these neurohumors in initiating and effecting various changes in the thyroid gland both in our experimental and clinical cases. But suffice it to say here that any such severe psychic trauma can initiate the liberation of acetylcholine followed by catecholamine to produce various physiological and sometimes pathological changes in the body.

IMMUNOLOGICAL RESPONSES

Here it is also possible to postulate that a prolonged and repeated vasoconstriction to any organ as a result of catecholamine liberation leads to necrosis of the organ. As it was seen that catecholamine was increased in most of these patients in the early period, it is possible to speculate that some reabsorption of such necrosed material into the whole body through the veins and lymphatic system led to the development of antibodies. When such antibodies come in contact with the necrosed area of the thyroid it may evoke a definite antigen-antibody response as a result of the development of the autoimmune phenomenon. Keeping Mallander's work in view it is quite

possible to postulate that the large number of lymphocytes and plasma cells present in the thyroid gland are capable of elaborating histamine and seratonin locally. Therefore, such antigen-antibody response causes liberation of histamine locally which would further aggravate the autoimmune phenomenon leading to marked cellular infiltration especially lymphocytes in the thyroid gland. Possibly it is this immunological response which leads to the liberation of LATS in these cases which perpetuates the disease for a longer period. As a result of this the TSH content in the blood becomes much less since its function would be taken over by the LATS produced by the lymphocytes and plasma cells present in the thyroid gland and also in the neighbouring lymphnodes and the thymus gland.

MATERIALS AND METHODS

On the basis of this hypothesis we conducted our investigations in the experimental set up and also on clinical cases. For the experimental purposes we used both *in vitro* and *in vivo* conditions.

IN VITRO STUDIES

The *in vitro* studies were conducted in an organ culture set up as described by us elsewhere. Briefly it consisted of removal of the thyroid gland from the chick embryo of 14 days duration. This was grown under different controlled media and also by adding various neurohumors. Thus, one could easily study the role of various neurohumors on the thyroid cells in the tissue culture for six days whereafter the growth of the cells stopped:

RESULTS

Amongst all the neurohumors we studied, we found that acetylcholine in the dosage of 1 μgm/ml is the most potent agent in producing hyperactivity of the thyroid gland. Histologically within six days the cuboidal acinar cells become columnar. The I^{131} uptake increases remarkably. The Elec-

tron Microscopic studies of this gland showed a marked increase in the number and size of the mitochondria indicating an enhanced metabolic activity in the thyroid cells. The administration of adrenaline and histamine also increased the I^{131} uptake upto 4th day and later on it decreased. Then we studied the sequential administration of acetylcholine, adrenaline and histamine for two days each. This regime showed marked histological changes such as hypertrophy of the cells at first, then villi formation and then cellular infiltration. The I^{131} uptake studies indicated sudden increase in the uptake 2 days after acetylcholine administration followed by gradual decline when changed into adrenaline and histamine administration. Thus I^{131} uptake, the histology and Electron Microscopic studies do indicate that acetylcholine is the most potent drug for stimulating and activating the cells of the thyroid gland *in vitro*. The other agents like adrenaline and histamine also stimulate the thyroid gland *in vitro* to a considerable extent but they are not so potent as acetylcholine (Fig. 64).

The sequential administration of these three agents brings about a picture almost similar to that seen in clinical thyrotoxicosis. Incidentally, we also tested the effect of LATS on the thyroid cells *in vitro* and we found a marked increase in the activity of the thyroid cells. Amongst the various combinations, LATS and histamine administration produced a marked increase in the activity of the thyroid cells indicating their synergestic action.

In vivo studies

CHICKEN

Since all the above *in vitro* studies had been carried out in chick embryo, we wanted to confirm these findings *in vivo*. Hence 2 month old chickens were selected for carrying out these studies. They were given injection of acetylcholine for 15 days (10 μgm) followed by 15 days of adrenaline (10 μgm) and 15 days of histamine (5 μgm). Again to our great surpise these studies fully confirmed the *in vitro* studies mentioned earlier

EFFECT OF NEUROHUMORS ON THYROID GLAND IN VITRO

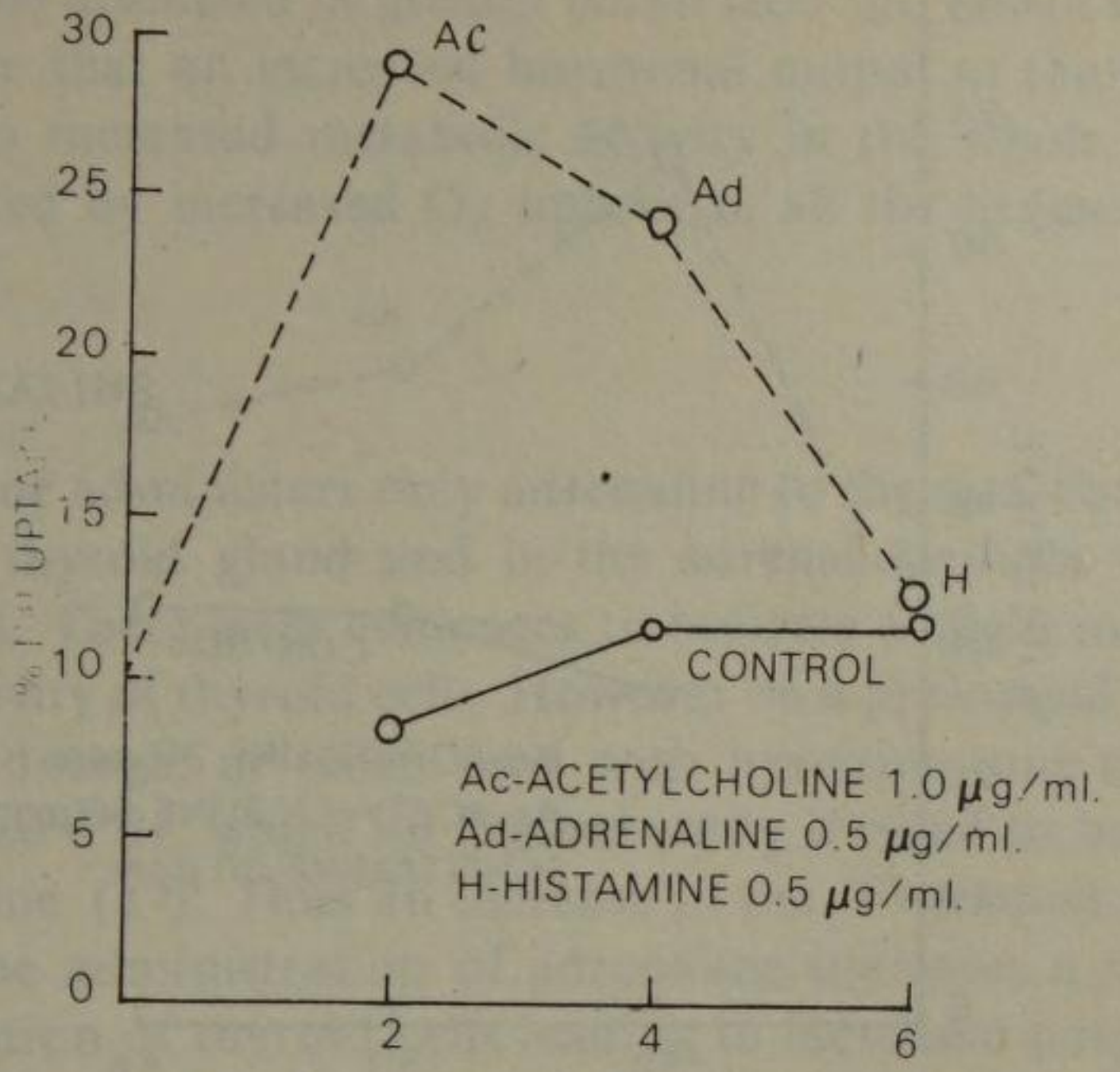


Fig. 64. Shows I^{131} uptake of the chick embryo thyroid following incubation with acetylcholine, adrenaline and histamine in sequence after every two days. Note an enormous increase of I^{131} uptake after acetylcholine as compared to controls.

(Fig. 65). Thus, histologically in the acetylcholine series there was marked hypertrophy of the thyroid cells. When adrenaline was administered one can clearly see the protrusion of certain areas of the cells into the acinar lumen giving rise to papillary projections typical of thyrotoxicosis. This was followed by histamine administration which showed an increase in the cellular infiltration probably of lymphocytes in origin. The I^{131} uptake and other studies also confirmed the functional increase in the activity of the thyroid gland following the administration of these agents.

Experimental Studies

ACETYLCHOLINE

Similar studies were also conducted on rats. The acetylcholine administration (10 µgm) again showed a marked hypertrophy of the cells with vacuolation in the celloid material. The

EFFECT OF NEUROHUMORS ON THYROID GLAND IN VIVO

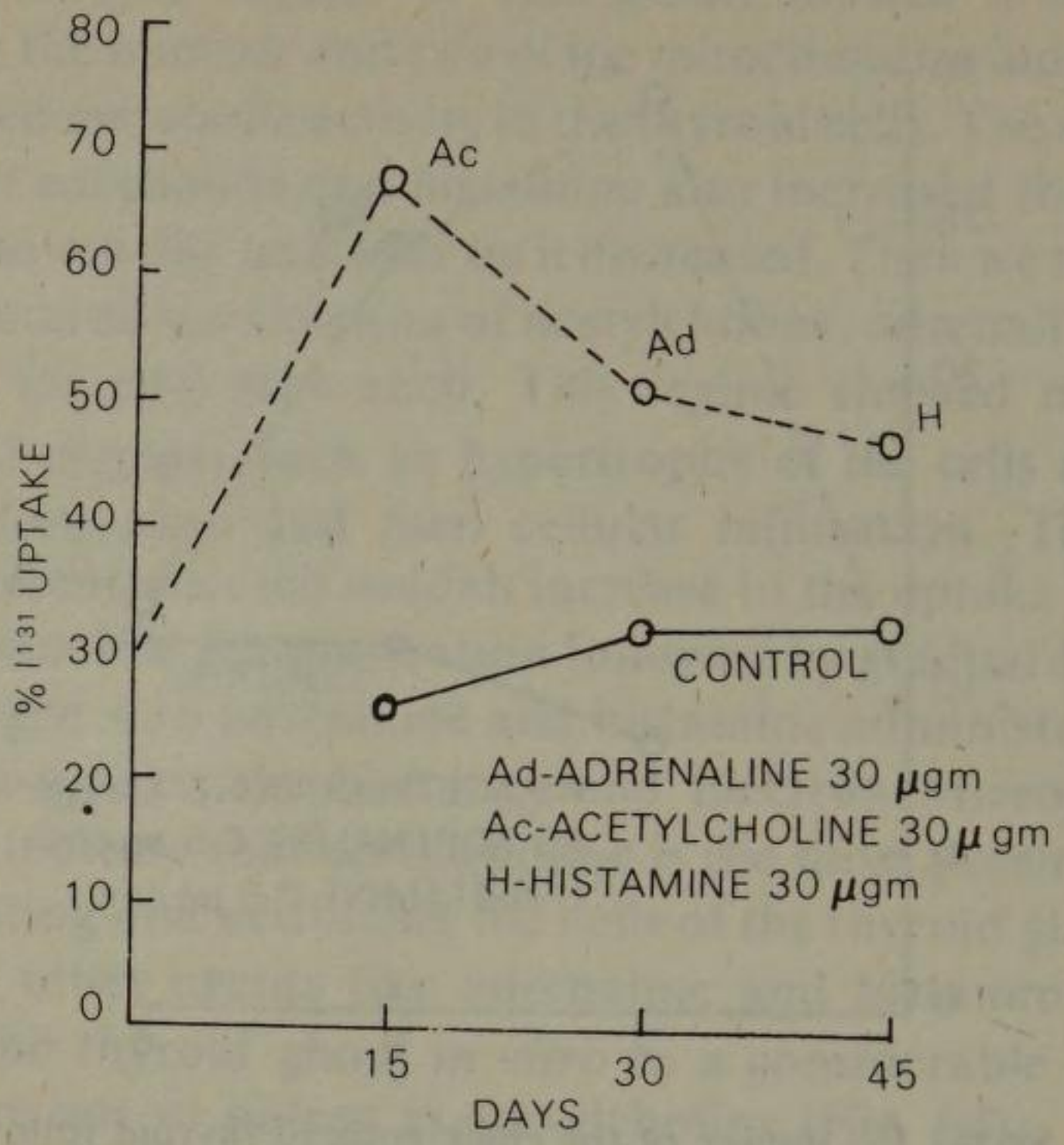


Fig. 65. *In vivo* studies of I^{131} uptake of thyroid gland in chicken after injection of acetylcholine, adrenaline and histamine in sequence after every 15 days. The *in-vivo* findings are almost similar to those of *in-vitro* studies.

I^{131} uptake increased and the serum PBI level also increased considerably from 4 μgm to 9 μgm within 30 days. Because of the increased PBI there was a marked increase in the O_2 uptake in the various organs studied such as brain, liver and heart when measured in the Warburg apparatus.

Similarly, one of the important enzymes involved in the synthesis of a catecholamine viz. PNMT was also in the adrenal gland. It is expected that the other synthesizing enzymes of catecholamine such as tyrosine hydroxylase (TH) and dopamine Beta hydroxylase (DBH) may also increase in these cases, though we have not so far estimated these enzymes. From all these findings one can safely say that the administration of acetylcholine to the rats produces increased activity of both the thyroid gland and the adrenal medulla leading to increased output of these hormones. Thus increased PBI and increased catecholamine synergistically act on the peripheral cells to do

more function through the medium of cyclic AMP which fact would be discussed in greater detail later on. It will suffice to say here that an increased hormonal output of these organs leads to increased metabolic activity in the whole body as evidenced by increased O_2 uptake in all the organs that we studied.

ADRENALINE

If one administers only adrenaline to the rats, the changes in the thyroid gland and in the adrenal medulla were not marked. There were evidences to indicate a slight increase in the activity of thyroid cells. However on a prolonged use or in higher dosage, or when used with hyroxine, one could get increased PBI, which on further study showed to be triiodothyroxine (T^3). Thus an increase in the T^3 content of blood after the administration of adrenaline indicates a moderate stimulation of thyroid cells leading to increased output of its hormone which is known as a biologically active part of the thyroid hormone. Such a condition has been observed by Johnston in surgical patients after the operations of different magnitudes. It is well known that in the postoperative period there is increased out-pouring of adrenaline on the second day and onwards and this is followed by increased T^3 in blood from the third day onwards. Such a clinical observation in a stressful situation closely resembles the present observation of T^3 increase following adrenaline administration in rats.

HISTAMINE

Administration of histamine to the rats in the dosage of 5 μg/kg did not cause much change in the thyroid gland excepting some insidious inflammatory changes in the form of infiltration with lymphocytes and plasma cells. Such chronic inflammatory process went on increasing as the time passed and it was followed by evidences of fibrosis. Functionally in the initial period of the first two weeks there was not much change, and the PBI remained within normal limits. However, in the 3rd and 4th weeks we could observe a marked

increase in the serum PBI indicating that such a chronic inflammatory change which closely resembled the picture of autoimmune thyroiditis causes hyperfunctioning of the thyroid gland. However, when we stopped the administration of histamine all these changes disappeared slowly and hence it appeared that it was a reversible phenomenon. Whether these animals develop an autoimmune phenomenon leading to liberation of LATS like substance or not needs further study.

COMMENTS ON EXPERIMENTAL STUDIES

From all these observations in rats we have come to the conclusion that stress causes in the initial period a rise in acetylcholine followed by a rise in catecholamine. Both these phenomena produce marked changes in the neural, endocrinal, and systemic organs. In the endocrinal apparatus, hypothalamic region and adrenal medulla are the first to react to the liberation of acetylcholine. Thereafter the manifestation of pituitary adrenocortical response which had been so extensively studied by Selye and others would occur.

The thyroid gland is the next organ to become active as a result of excessive liberation of acetylcholine which is subsequently perpetuated by the excess amount of circulating catecholamines. If the stress situation continues or if there are recurring attacks of psychosomatic stress for a long period the excessive supply of catecholamine to the thyroid gland will lead to prolonged vasoconstriction at the arteriolar level. It is this state which leads the thyroid gland to develop autoimmune phenomenon as a result of liberation of histamine in the gland itself which causes capillary dilatation especially at the venous end. Through these vessels it is stated that certain cellular fractions, especially the microsomal fractions, are reabsorbed. Similarly the lymphatic channels may also reabsorb these materials leading to the development of autoimmune phenomenon as already discussed which is responsible for the perpetuation of the disease till it subsides by the antithyroid measures or by its own accord by fibrosis.

CLINICAL INVESTIGATION

Material and Methods

In all we have examined and treated 770 cases of thyrotoxicosis during the past 12 years. A detailed history was prepared and physical examination of all these cases was carried out as per the prescribed proforma of the thyroid clinic. In this, special emphasis had been laid down to elicit the psychological stress received by the patient in the past so that it could be easily correlated with the onset of present complaint. In the physical examination, the neurological, cardiovascular and ophthalmological manifestations were given due importance.

In the laboratory studies of serum PBI and serum cholesterol were carried out in all the cases as a routine, in addition to the usual haematological studies. Radioiodine uptake studies upto 24 hours and wherever feasible the PBI^{131} studies were also carried out. In our earlier studies we had also conducted the total thyroxine, free thyroxine and T_3 resin uptake in 100 cases and from this a free thyroxine index was calculated. However, after conducting all these studies we had come to the conclusion that if all the precautions are taken to withhold steroid intake, the estimation of serum PBI level gives the most reliable index of thyroid function and hence as a routine we followed it in our studies.

In addition, recently in 180 cases of thyrotoxicosis we also estimated the neurohumoral content of blood, namely quantities of acetylcholine, catecholamines and histamine as per the techniques described by us earlier. The results of these studies were compared with the different clinical features so as to give proper explanation for their manifestations.

THERAPEUTIC TEST

Once the diagnosis was fully established the patients were treated by one of the three methods of management namely antithyroid drug carbamizole, radioactive iodine and surgery. We used carbamizole in the early cases of young persons and pregnant women. In older people above the age of 35 years, we used radioactive iodine in 5 millicurie dosage, which was

repeated if required after 4 months. In large thyroid glands, with marked clinical features and with the failure of above treatment, subtotal thyroidectomy was carried out. We observed during the course of our study, that though by all these antithyroid measures, many of the clinical features disappeared, still a large number of other accompanying features would not subside. Later on when we measured the neurohumors we came to the conclusion that since thyrotoxicosis is primarily a systemic disorder, we have to treat the remaining clinical features on the basis of the abnormality of the neurohumors in blood. Hence in our recent cases, we gave for acetylcholine predominence cases—tranquillizers, patients with high catecholamine content propronalol (the beta-adrenergic blocker), and in histamine predominence, prednisolone. By the introduction of these additional measures along with antithyroid treatment we could get a very satisfactory response in most of these cases to be discussed later on.

RESULTS OF CLINICAL STUDIES

We observed that this disease is more common in women than in men. Further, it is more often seen in the age group of 20 to 40 years than others. It is also observed that these patients do not seek medical advice immediately after the onset of the disease since it has a very insidious onset and the patient cannot trace out the exact date from which his or her trouble started. However, on close questioning one can invariably trace out the early beginning of the trouble from the date of receiving some sudden severe psychological trauma. Sometimes initially the patient may refuse to give a definite history of receiving any such stress, since most of these patients are "introverts" in their psychological behaviour. However, on repeated questioning and by the perseverence of the attending physician one can always get the history of having received some severe psychosomatic stress in these patients. On psychological testing we find that anxiety scale in these patients had also increased considerably indicating that inherently they have a greater susceptibility to get such disorder as a result of stress. Because

of this only, some, of our early cases were labelled as anxiety neurosis and treated as such in the beginning. It is only at a later stage with all the clinical features of thyrotoxicosis fully developing, that a diagnosis of thyrotoxicosis was established.

Case history

Miss A.P., a 30 years old Deputy Inspectress of Schools, came to us with a history of nervousness, palpitation, sleeplessness, irritability, and mild tremors in the hands and feet. On questioning she told us that about 3 months ago she had a severe nervous breakdown due to the sudden death of her father which ultimately resulted in a breakdown of her engagement for marriage. During this period her brothers also completely deserted her and as a consequence she became a nervous wreck. On physical examination, there was a slight increase in the pulse rate upto 90 per minute and a slight tremor in her fingers. Otherwise, there were no other clinical features. The neurohumoral studies indicated an increase in the acetylcholine content upto 3.00 μg per litre which is three times higher than normal. Hence we labelled this case as anxiety neurosis and treated by adequate dosage of tranquillizers, in the form of Meprabromate 800 mg per day and in addition she was also put on yogic exercise. However, due to certain family circumstances she could not continue the treatment for more than 2 weeks and stopped it.

We were really surprised to see her again after six months, with all the classical clinical features of thyrotoxicosis with exophthalmos, enlarged thyroid gland, rapid pulse upto 140 per minute, and marked tremor in the fingers. Our laboratory investigation showed PBI—11 μg per cent, serum cholesterol 20 mg% and the radioiodine uptake was 70% at the end of 24 hours. The neurohumoral studies showed acetylcholine 2.5 μg per litre, and catecholamine was 300 μg/litre which is slightly higher than normal. We again put her on a heavy dose of tranquillizer along with antithyroid measures which gave her a considerable relief from her trouble. When we saw this patient again after one year, she had almost got rid of all the troubles;

but we are keeping a close watch on her progress.

From this case report one can say that at the early stage of the disease there is more of neurosis with marked increase in the acetylcholine level which later on would lead to the development of thyrotoxicosis in the susceptible psychosomatic personalities. Further, it appears that when the clinical features of thyrotoxicosis fully manifested themselves the level of acetylcholine becomes less and the level of catecholamine gradually increases.

In the physical examination we observed that at the early stage of the disease, one usually observes more of neurological manifestation with hyperfunctioning of the entire central and peripheral nervous system. At this stage we found a minimal thyroid enlargement. It is mostly in the second stage of the disease that one can see the clinical features of marked cardiovascular involvement such as palpitation, rapid pulse, increased systolic blood pressure etc. At this stage the thyroid gland is moderately enlarged with soft spongy feeling. There is usually a visible pulsation over the gland or bruit.

At the third stage, the patient becomes somehow adapted to the clinical features and his neurological features become much less. The symptoms of circulatory system persist to a considerable extent though the patient does not complain much about them. There is usually a marked exophthalmos at this stage and the thyroid gland also becomes firm and uniformly enlarged. There may be some enlargement of the cervical lymph nodes also.

Laboratory studies greatly helped us to divide our cases in accordance with the above three stages. At stage I, the PBI level is slightly increased, the serum cholesterol level may be found decreased, but the most significant finding is the increased plasma acetylcholine level which can explain the increased activity of the central and peripheral nervous system. I^{131} uptake is either at the upper limit of the normal or slightly increased.

At stage II, the PBI level is much increased and the serum cholesterol level is decreased, and the most significant finding

is that there is increased catecholamine content with evidences of increased turnover of this neurohumor. This finding would explain the marked increase in circulatory features of this stage. The I^{131} uptake rises considerably and it reaches usually the level of 70 to 80%.

At stage III, the PBI level still remains high and the cholesterol level remains much low. But the most significant laboratory finding is the increased histamine level of plasma indicating a setting up of autoimmune phenomenon with marked lymphocytosis and plasma cell infiltration of the thyroid gland. The I^{131} uptake shows an increase, but it is usually less than that of stage II, and it remains at the range of 60 to 70% at the end of 24 hours.

From these clinical and laboratory findings we can invariably determine the stage of the disease the patient is suffering from and the type of management one should prescribe to each one of these patients. By this time we have definitely come to the conclusion that grouping all the cases of thyrotoxicosis on the basis of the finding of thyroid hormone alone cannot give a complete picture. Hence in addition to studying the thyroid function, the study of neurohumors in these cases is most essential for proper evaluation of the condition and also for the management of these cases.

Results of therapeutic test

Therapeutically also, we could confirm the role of these neurohumors in the genesis and manifestations of thyrotoxicosis. Initially when we were not fully conversant with the role of these neurohumors we used to follow only the standard method of treatment, namely antithyroid drugs; we invariably used carbimezol (Neomercazol) 30 to 60 mg per day. This was used in all the cases as the initial method of management and it became a definitive treatment for the majority of children and young adults. Similarly, pregnant women were also treated only with this drug to tide over the situation. However, the results were not uniformly good—we could get good results in nearly 50 per cent of the cases only.

Radioactive iodine was given to those cases of thyrotoxicosis who were above 35 years as a definitive measure from the very beginning. We also used it as a second line of treatment in the age group of 30 to 35 years, if the usual medical measures failed to give relief. Our dosage in the initial period was 5 Mc only and we repeated the dosage if needed after 3 months. We were very cautious in the administration of I^{131} to avoid hypothyroid state. Later on the overall cure rate of I^{131} administration in the above manner was in the range of 90%.

In our centre, surgical treatment was given to those young adults who had a large goitre, and who could not get relief from antithyroid drugs. We also used surgery in all the other cases who could not get any relief either from antithyroid drugs or from radioactive iodine. In such cases, irrespective of their age or size of gland a standard subtotal thyroidectomy was done with one anaesthetic death in an old man of 60 years. The result of surgical treatment was 90% relieved.

However, to our utter disappointment we found that the initial relief from the above mentioned standard therapy did not last long and we also found that they were not the normal individuals both psychologically and physically when we followed for a longer period. Though in most of the cases the function of the thyroid gland remained within normal limits as evidenced by the PBI findings, there were other accompanying manifestations which still persisted in them. These manifestations were usually nervousness, palpitation, irritability, sleeplessness, periodical attacks of tachycardia and different types of emotional disturbances. We could not give these patients any more of antithyroid measures in view of the fact the serum PBI remained within normal limits.

Hence, we resorted to the use of tranquillizers and later on Beta adrenergic blocking agents as was done by others rather indiscriminately with variable results. We were not happy with our new approach to the treatment since we did not have any scientific basis as to when to place emphasis on what drug. However, when we started estimating the neurohumors in the blood of these patients and we completed our studies of neuro-

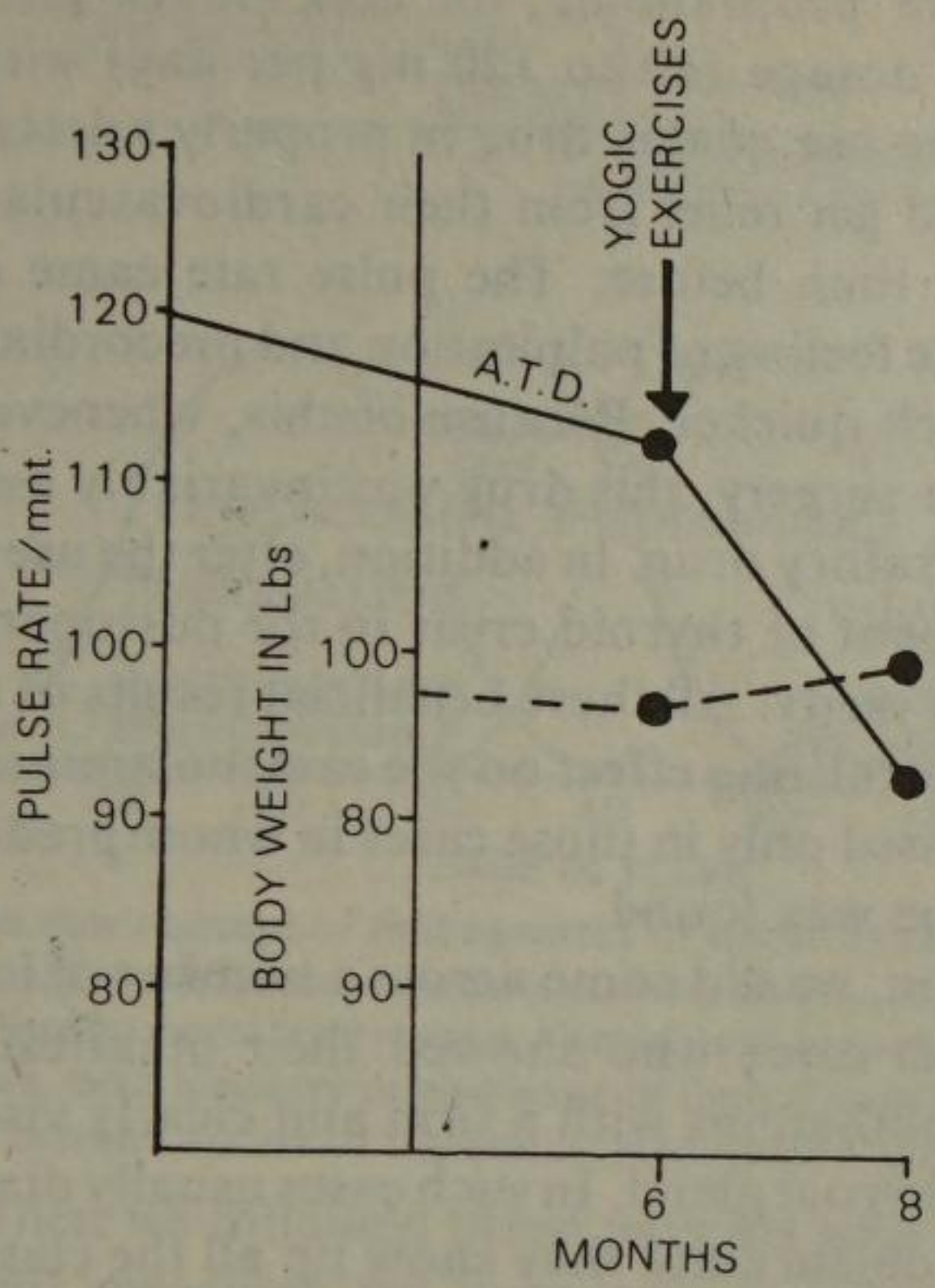


Fig. 66. Shows the body weight and pulse rate response of a persistent thyrotoxicosis case treated with anti-thyroid drugs (ATD). Since very little response was noticed, the patient was put on yogic practice with quick beneficial results.

humors on experimental animals, we could establish a scientific basis for taking these additional measures.

Thus, in those cases of thyrotoxicosis who came to us in the early stage with high acetylcholine content in the blood, we invariably gave tranquillizers in high dosage so that we could control their symptoms of 'neurosis' from the very beginning. For this we used meprabromate, diazepam or other similar drugs. Sometimes we had to use major tranquillizers also, such as chloropromazine to control the unstable emotional state accompanying this disease. The results of these additional measures such as Yoga in addition to the above antithyroid measures were remarkably good. They felt better much earlier and they gained confidence in themselves sooner (Fig. 66).

Similarly in those cases which had severe cardiovascular manifestations and had shown high catecholamine content of

blood we gave 'propranolol', the beta adrenergic blockers, in the required dosage (40 to 120 mg per day) with gratifying results. By the use of this drug in properly selected cases, the patients could get relief from their cardiovascular symptoms much earlier than before. The pulse rate came down much faster, and the feeling of palpitation and precordial discomfort subsided much quicker. Because of this, whenever they were submitted for surgery, this drug was invariably used as preoperative preparatory drug. In addition, after the use of this drug, the development of thyroid crisis in the postoperative period has become a rarity. All these beneficial results of this drug are due to its neutralizing effect on the catecholamines and hence, it should be used only in those cases in whom predominance of catecholamine was found.

In addition, we did come across a number of long standing thyrotoxicosis cases who showed their manifestation in the form of exophthalmos with a firm and clearly visible enlargement of the thyroid gland. In such cases usually diagnosis is not a difficult problem since they show up all the classical clinical features of the condition. At this stage, all the manifestations of autoimmune phenomenon can also be seen in the laboratory studies. They will have high lymphocytic counts and an examination of neck may reveal a few enlarged lymph nodes. The neurohumoral studies will invariably show a rise in the histamine content. In addition the Tanned Red Cell Test (TRC) may become positive and if facilities are available the LATS (long acting thyroid stimulations) will also be positive. In such cases, in addition to all the other measures, prenisolone 15 mg a day greatly helped to get over their troubles. However, it takes quite some time before they can get full relief from their trouble. We had to use this measure along with other antithyroid treatment for a longer period since the patients usually have a very long history.

Here, one should remember that sometimes these three stages may be overlapping and one has to give more than one drug to control the neurohumors such as tranquillizers and propranolol, or prenisolone and propranolol etc. to get a last-

NEW CONCEPT OF MANAGEMENT OF THYROTOXICOSIS

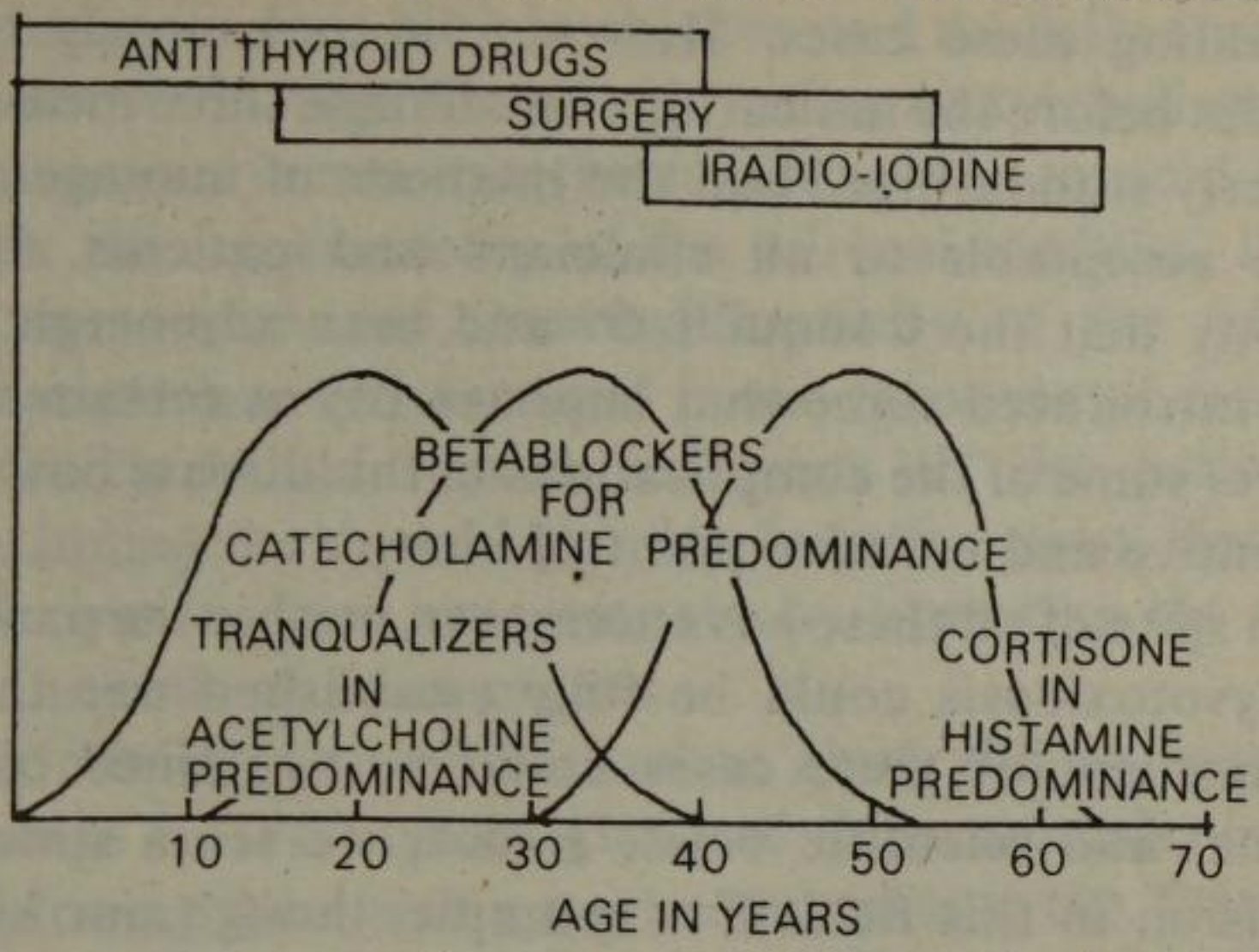


Fig. 67. Shows new concept of management of thyrotoxicosis. Thus, along with the standard antithyroid measures namely drugs, surgery and radio-iodine, anti-neurohumoral treatment is also advised in each case in the form of tranquillizers, beta blockers or cortisone in high dosage depending upon acetylcholine, catecholamine or histamine predominance respectively.

ing relief. When we followed those patients who had received the additional measures we were greatly satisfied with the results, not only from the point of view of objective measures, but also from that of subjective feelings. Thus, by our experimental and clinical study we can now aspire to give complete relief to all these patients by planning from the very beginning, both antithyroid and antineurohumoral measures (Fig. 67).

Observations

Although a details study of thyrotoxicosis, especially of its clinical features was carried out by a number of workers towards the end of the last century, the details of the therapeutic measures taken to treat this condition were standardized to a considerable extent in the first half of this century. At first surgery became the only means to control thyrotoxicosis, thanks to the pioneering work of Kocher Duubill, Mayo, Lahey and others. However, in the years 1942-45 two additional measures namely antithyroid drug and radioactive iodine were introduced, with considerable measure of success

in treating these cases. However, it took nearly two more decades before the indications for all these three measures were properly standardized and the methods of management were made acceptable to all clinicians and patients. It is only recently that the tranquillizers and beta adrenergic blockers were introduced somewhat haphazardly at certain centres to control some of the complications of this disease both from the preventive and curative point of view.

In spite of all these advancements, neither the pathogenesis of thyrotoxicosis could be fully established nor the overall management of these cases could be explained on a more rational and scientific basis. Hence, we see a state of utter confusion in this field. For example, though our knowledge with regard to synthesis, turnover and metabolism of catecholamines has enormously increased in recent years, yet there is still a lot of confusion with regard to catecholamine's role in this condition. There are few reports to indicate that catecholamine content is increased in these cases, whereas others observe that there is no change in that in this disease. At the same time, there are few reports to indicate that catecholamine activity is decreased in this disease. But all these findings were made in clinical cases alone and there is no experimental basis for making any such statement.

Thus, in order to elucidate these matters and to remove the present day confusion we first started with our experimental studies both *in vitro* and *in vivo*. Our *in vitro* studies of thyroid gland of chick embryo clearly demonstrated that it was the acetylcholine which was capable of quickly influencing the thyroid gland leading to hypertrophy and hyperplasia of its cells. Neither adrenaline nor histamine possesses any such power to initiate the process. However, once such a hyperplasia is produced by acetylcholine, adrenaline is capable of maintaining the hyperactivity for quite some time. On changing this gland to the media containing histamine the activity of the gland tends to become normal. No other neurohumoral sequence could produce such uniform result as the above sequence.

Our studies *in vivo* both in chicken and rat fully corroborated the above finding. Thus, on injecting acetylcholine there was an enormous increase in the activity of the thyroid gland along with the hyperactivity of the adrenal medulla. If this injection was continued, the hyperactivity of the adrenal medulla caused marked increase in the turnover of catecholamines which would further influence all the peripheral organs including the thyroid gland to hyperfunction. Here, the catecholamines induce hyperactivity by liberating the cyclic AMP in the cells of these organs.

The administration of adrenaline alone did not produce much change in the thyroid gland of these animals, but on giving thyroxine there was a marked increase in the T^3 level of these animals indicating hyperactivity of the thyroid gland.

On histamine administration one could see a typical microscopical picture of autoimmune phenomenon with marked lymphocytic and plasma cell infiltration on the thyroid gland. If this injection is continued for more than two weeks one can usually get an appreciable rise in the serum PBI level.

These findings in the experimental animals and in organ culture tend to show that all the three neurohumors mentioned above become active in a sequential manner following an onslaught of psychological stress. It is not an entirely new observation, since we had earlier found a similar pattern of rise of neurohumors in traumatic stress though of shorter duration. Thus, following trauma also at first there was an increase of acetylcholine for 3 days followed by a rise in catecholamine content for the next 5 days. Thereafter, there was a rise of histamine level till the healing process was completed. In the same way, in thyrotoxicosis also it seems that psychological stress causes at first high rise in the acetylcholine content by stimulating the cerebral cortex, limbic system, posterior hypothalamus, and all the cholinergic nerves in the body. If the stress continues, this is followed after a variable period of time by a rise in the catecholamine content, along with increased catecholamine turnover which further stimulated the thyroid gland. In due course of time, in an attempt to overcome the

trouble, the autoimmune phenomenon develops with an increase of histaminergic cells in the thyroid gland which again keep up the high activity of thyroid cells till the gland is completely destroyed. This is probably the most plausible scientific explanation for pathogenesis of this important stress disorder, thyrotoxicosis.

Our clinical investigations and laboratory studies of neurohumors in these cases fully corroborated the above mentioned experimental data. Thus, in the cases of short duration there were marked features of neurosis with increased acetylcholine content. Our later cases showed either increased catecholamine content or increased turnover of catecholamine along with increased involvement of cardiovascular system. Our more advanced cases of thyrotoxicosis, with typical features showed various manifestations of autoimmune phenomenon in the form of increased histamine content, raised lymphocytes in the blood, and marked cellular infiltration of the thyroid gland with plasma cells and lymphocytes.

Therapeutically also, we could confirm these observations with heavy doses of tranquillizers at the early stage with an increase in the acetylcholine content and with beta blockers when we encountered high catecholamine activity. In the advanced stage we could treat them with corticosteroids with some benefit though it usually took longer time to show the good results.

Thus, from all the above scientific investigations we can say now with some confidence that the main riddle of pathogenesis and management of thyrotoxicosis is gradually being solved though we still have to find out at the cellular and molecular level how exactly these neurohumors stimulate the thyroid gland and how jointly thyroxine and neurohumors activate the peripheral organs and tissues. These are some of the topics which need extensive investigation in future.

SUMMARY

1. Although the classical clinical features of thyrotoxicosis had been described about one and half centuries ago, the

exact etiology and rational treatment for this condition has not so far been found out.

2. In the present study, an attempt has been made to investigate this problem by using both experimental and clinical methods. On the basis of these findings we can offer a fairly satisfactory explanation with regard to etiology and treatment of this condition.
3. As per our earlier studies on traumatic stress in which we noticed sequential elevation of neurohumors namely the acetylcholine, catecholamines and histamine, we postulated that even in thyrotoxicosis which is mainly caused by psychosomatic stress, similar neurohumoral response may be operating in sequences of longer duration.
4. Our *in vitro* studies of thyroid gland in organ culture clearly showed that acetylcholine had great capacity to produce marked hypertrophy and hyperplasia of thyroid cells. Such changes could be maintained for a longer period by adding adrenaline to the media and later on by histamine.
5. Our *in vivo* studies in chicken and rats fully confirmed the *in vitro* findings. In these experiments acetylcholine injection rapidly enhanced the thyroid activity. This was further extended by adrenaline injection when it was given together with thyroxine. Lastly, histamine injections caused a severe autoimmune phenomenon in the thyroid gland just as we saw in the late stages of thyrotoxicosis.
6. Our clinical studies fully confirmed the above findings. Thus, at the early stage one observes a large increase in the acetylcholine content along with symptoms of neurosis. This is followed after some time by an increase in the catecholamine content in blood along with cardiovascular fetures. In the late stages, one sees the autoimmune phenomenon along with a rise in histamine content.
7. Therapeutically also in the early stages, only the tranquillizers along with antithyroid measures would produce good results. In the second stage with excess of catecho-

lamine turnover, beta adrenergic blockers produce their desired results. In late stages with autoimmune phenomenon prenisolone treatment gives beneficial results though rather slowly.

8 In short, it appears that stress causes increased activity of the cerebral cortex, followed by the stimulation of limbic system, posterior hypothalamus and thereafter the autonomic nervous system. Even here, the cholinergic nerves are activated at first followed later on by adrenergic nerves and adrenal medulla. These neurohumors are gradually neutralised by the local liberation of histamine in the thyroid gland which ultimately causes resolution or healing by fibrosis.

9. However, this explanation does not make it clear as to why only few persons get thyrotoxicosis following stress, though every person is exposed to different types of stress and strain some time or the other in his life. This is a subject for future study. Probably genetic factors leading to inherent deficiencies of some of the neutralizing enzymes of these neurohumors such as cholinesterase, monoaminoxidase or histaminase in the thyroid gland may predispose the persons to get this disease. However, this needs further confirmation especially in those who have a family history of thyrotoxicosis.

10. Lastly, the mode of action of thyroxine and the neurohumors together on various organs and peripheral tissues need immediate exploration. Probably, they produce their joint action through liberating cyclic AMP in the cells of these organs. This also needs further investigation.

11. Here, it is further postulated that just as in thyrotoxicosis, all these neurohumors might be playing a similar role in the pathogenesis of all the other stress disorders such as coronary thrombosis, hypertension, peptic ulcer, ulcerative colitis etc. Hence an entirely new approach based on neurohumoral studies is urgently needed to investigate all these problems in greater detail so that effective measures could be taken to treat them all in time.

CHAPTER 21

Stress and Diabetes Mellitus

Historical Background

Diabetes mellitus is a common disease seen all over the world since antiquity. The ancient Indian physicians like Charaka and Sushruta had discussed this condition in sufficient detail in the 5th century B.C. They had clearly stated that hereditary factors played an important role in the development of this condition. In the etiology, they had mentioned two important factors, namely, dietary indiscretion and sedantary habits with lack of exercise which were responsible for the incidence of this disease. As a result, all the bodily humors in their opinion, were disturbed which mainly affected the fatty tissue causing its degeneration and excretion through urine. The treatment suggested was the administration of a number of bitter drugs and sufficient amount of exercise with a strict dietary control. Here, they had also coutioned that the disease with a hereditary background was difficult to treat. From this, one can say that this condition was known since long and the ancient physicians had observed their patients very closely with regard to their pathogenesis and proper management.

From the West, Celsus and later on Avicenna from the Middle East wrote detailed account of this condition in the early period. But our knowledge with regard to diabetes mellitus had a great stimulus from the epoch making discovery of insulin by Banting and Best in the year 1921. This not only helped us to treat our patients effectively, but also to know more about the pathogenesis and pathology of this condition. The introduction of oral antidiabetic agents in 1955 had given further stimulus to the study of these patients in greater detail. All these discoveries greatly helped to control the diabetic condi-

tion which is now increasing all over the world. It is found more in urban population than in the rural areas and its incidence is much more in the advanced countries than in the developing countries. It appears that the modern life with its ever increasing stress and strain has greatly contributed to the rapid increase in the incidence of this condition in the more civilised communities. Therefore if one wants to put a halt to the rapid increase in the incidence of diabetes mellitus, one will have to plan effectively as to how he can prevent the people from becoming victims of stress and strain. It has been recently reported that most of the oral antidiabetic agents produced certain toxic effects if used for a prolonged period. As a result, people using these drugs are liable to get greater number of complications, especially of the cardiovascular system than others who are not put on such drugs. This has resulted in a reappraisal of the use of these drugs causing much confusion both in the minds of physicians and their patients. Because of these recent developments in the field of management of diabetes mellitus, there is an urgent need for our understanding of the pathogenesis of this condition, so that one can plan an effective management both from the point of view of prevention and also from the point of curative treatment.

Etiology

Althogh various known factors such as heredity, obesity and infection have been extensively studied to determine their role in the causation of diabetes mellitus, no definite conclusions have yet been reached. However, comparatively very few studies have been conducted so far to evaluate the exact role of psychic trauma or stress in the causation of this disease. This is because of the fact that we did not have any definite scientific and physical measures to assess the role of stress in the causation of the disease. However, the recent introduction of biochemical investigations such as estimation of catecholamines and cortisol in blood and urine has greatly helped us to measure the amount of stress a person has developed in the course of his daily life. Therefore, it is high time that in addition to the

introduction of various subjective psychological measures, the biochemical assessments of each individual patient were made as would help us greatly to know how the person responds to different types of psychosomatic stress.

There was a suggestion that psychic stress causes increased secretion of adrenaline which causes hyperglycaemia leading to the development of diabetes mellitus. However, this concept has not been readily accepted by many, unless a marked predisposition for the development of diabetes mellitus such as hereditary factors and obesity are also taken into account. Of the various emotional factors, prolonged state of anxiety and emotional conflict have been labelled as the precipitating factors which may act through neuroendocrine apparatus originating at the hypothalamus. However, in spite of all these possible factors, people have not yet fully understood the role of stress in the causation of diabetes. So far it has been agreed that if a predisposition for deranged carbohydrate metabolism already existed in a person, mental stress may precipitate the development of this disease much earlier. Similarly, prolonged stress in a given patient may make the person susceptible to develop this disease. Whether there is any scientific basis for such a relationship between stress and diabetes mellitus, can be understood by studying the neural control of functions of islets of Langerhans which regulate the output of insulin in the body.

CONTROL OF ENDOCRINE PANCREAS

According to Woods and Porte (1974) pancreas receives a generous supply of nerve fibres which enter the gland through its arteries. They originate in the caeliac and superior mesentric plexus and contain 3 types, namely parasympathetic from the vagus, sympathetic and visceral afferent fibres. Through these nerves only, the islets of Langerhans receive a rich supply.

It is now well established that adrenaline inhibits the secretion of insulin whereas it stimulates the glucagon secretion. The drugs which block the alpha receptors reverse its action of insulin inhibition whereas beta blockers do not have any such action. On the other hand, cholinergic drugs have a stimula-

tory effect on the beta cells of the islets which can be blocked by atropine. There are evidences to indicate that these drugs also stimulate glucagon secretion. Further, it has also been observed that the stimulation of vagus nerve reduces blood sugar by increasing insulin secretion.

ROLE OF HYPOTHALAMUS

It has been observed that alteration in the brain function may change blood sugar. This is especially so of the hypothalamus. Thus, electrical stimulation of ventro-lateral hypothalamus (VLH) causes decrease in blood sugar and an increase in plasma insulin. If vagotomy is done following this, no increase in the insulin is noted. Electrical stimulation of ventromedial hypothalamus (VMH) causes a decrease in the plasma insulin. Thus the stimulation of VMH which is a sympathetic centre causes decrease in insulin secretion and VLH which is the vagal centre increases the secretion of insulin. Similarly, there are evidences to indicate that insulin secretion increases after ingestion of sugar which occurs reflexly through the cerebral cortex and the vagus nerve.

ROLE OF STRESS

From the above, it becomes clear that the autonomic nervous system plays an important role in the secretion of insulin and glucagon. Thus, during stress there is excessive stimulation of sympathetic nervous system leading to decreased insulin secretion. Similar responses are also seen when catecholamines are found chronically increased such as in pheochromocytoma. Recently, it has also been observed that glucagon secretion increases during various types of stress. With regard to the parasympathetic nervous system it was found that its stimulation is weak and it occurs only to a limited number of functioning beta cells of islets. Because of all these changes in the islet cells, in psychic stress of long duration blood sugar level remains high.

Although diabetes has many metabolic problems including its genetic component, it seems that its many features can be

BAR DIAGRAM SHOWING MEAN CATECHOLAMINES ACCORDING TO SEVERITY IN DIABETIC PATIENTS AND CONTROLS

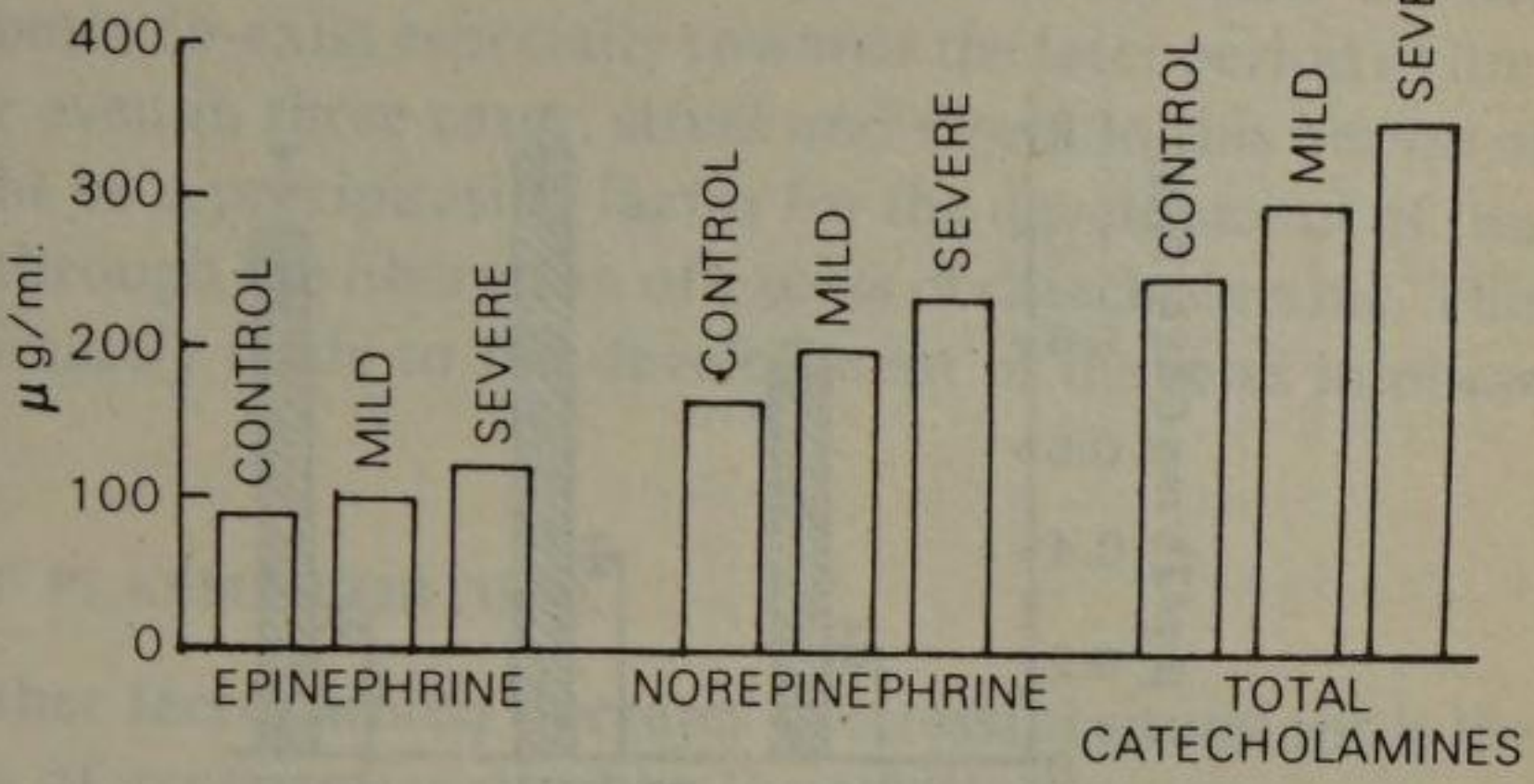


Fig. 68. Shows the level of catecholamine in different degrees of diabetes. From this one can say that the more severe the diabetes, the more is the circulation of catecholamine in blood causing further complications in these patients.

due to hyperactivity of the sympathetic nervous system (Fig. 68). Symptoms common to both diabetes mellitus and sympathetic overactivity include raised blood sugar level, decreased glucose tolerance, increased lipolysis, glycogenolysis and ketosis. Therefore, one can suspect that these two abnormal states can interact in an additive manner. This can be further confirmed by the fact that in stressful situations, diabetic patients develop an increase in ketones just as after administration of catecholamines to these patients. If beta blockers are given prior to such administration, no ketones are seen in acute stressful situations in these patients. Further, it has also been seen that plasma catecholamines are raised in poorly controlled juvenile diabetes which can be improved by efficient insulin therapy. From all these findings one can say that in severe diabetes, reversal of increased catecholamine content may be an important step towards its full control. It is here that the various yogic measures which would reduce the catecholamine content of blood can play their significant role in controlling certain specific type of diabetes to be described later (Fig. 69). Reviewing this subject Woods and Porte state: "Therefore there is evidence that catecholamines are elevated

CHANGES IN CATECHOLAMINE EXCRETION BEFORE AND AFTER TREATMENT IN PATIENTS OF DIABETES

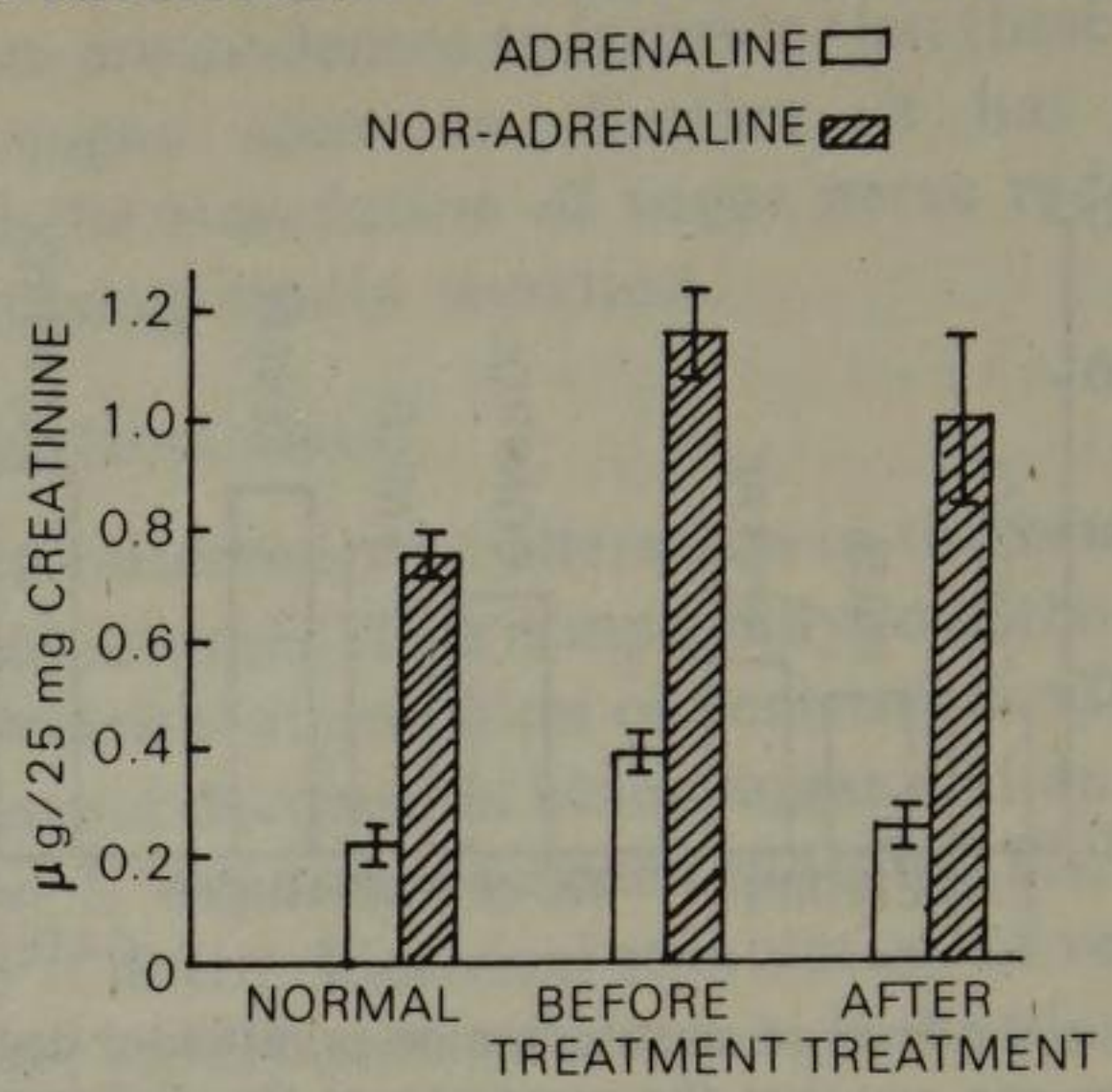


Fig. 69. Shows decrease of catecholamine content in the urine of diabetic paients after the practice of Yoga for 3 months.

in some poorly controlled diabetes or unusually effective in others and the stressful situations can lead to exaggerated diabetes symptoms... It was demonstrated that emotional stress can precipitate both the onset of diabetes in those who are genetically predisposed to it and the incidence of severe Ketoacidosis in diagnosed diabetes. Presumably any stressful situation can be expected to precipitate the onset of clinical hyperglycaemia. Therefore although genetic constitution clearly plays an important role in the underlying etiology of diabetes environmental stress may be influential in determining its clinical presentation". From these statements it will be easy to conceive that psychosomatic stress cannot only trigger off the onset of diabetes in a susceptible person through the excessive liberation of catecholamine, but also that the stressful situation may be the main determining factor in the development of various complications of diabetes mellitus, such as atherosclerosis, infection, myocardial infarction etc.

It is known that the more obese a person the more is the basal insulin secretion, possibly due to hyperactivity of the parasympathetic nervous system as a result of overactivity of its hypothalamic centre. If such hypersecretion of insulin con-

tinues for a long time there are always chances that there occurs sooner or later exhaustion of beta cells leading to lack of secretion of insulin. Hence, it is found that many times obesity and diabetes co-exist especially towards the later period of life; however even in these cases, stress and strain in this period of life might be a precipitating factor for the development of this disease through the liberation of excess of catecholamine. This also ultimately leads to the development of diabetes in obese people.

ROLE OF PLASMA CORTISOL

Another factor which operates in stressful situations is the secretion of excess of cortisol by the adrenal cortex as a result of excessive stimulation of hypothalamo-hypophyseal system by the various cerebrocortical and subcortical centres. The excessive secretion of gluco-corticoids from the adrenal cortex into blood would lead to enhanced glycogenolysis and gluco-neogenesis which ultimately lead to the elevation of blood sugar concentration. Further, they also cause marked lipolysis, lipaemia and ketogenesis. However, it should be remembered that unlike catecholamine, cortisol has no direct action on the islet of Langerhans to influence its secretion. All the above states produced by cortisol, also lead to the development of the diabetic state. Hence in stress, when there is an increase of both catecholamine and cortisol, there is greater susceptibility to the development of diabetes mellitus with all its metabolic and tissue level disturbances. In the latter process, there is a decrease in the utilisation of glucose in the tissue and an increase in the serum levels of free fatty acids, followed by an increase in triglycerides, phospholipids and cholesterol levels. The change in the level of free fatty acids being very labile is a good indicator of glucose utilisation. All these changes in lipid metabolism are due to lack of insulin in the blood which leads to accumulation of ketones and other products in blood which further induces various complications in diabetic patients. Thus, excess of psychological stress not only causes psychic and neuroendocrinal changes but also various metabolic and

tissue changes leading to the development of stress disorder of a particular organ. Those people who had inherited genetic weakness of islets of Langerhans and who after birth had shown tendency to obesity became the victim of diabetes mellitus on exposure to repeated stress and strain of life causing all the changes discussed above. However, in order to study the role of each of the above factors Prabhakar Rao, Bajpai and myself have conducted certain neurohumoral studies on these diabetic patients with some interesting results to confirm the above hypothesis.

OUR STUDY

In this study, Rao *et al* took 82 patients of diabetes mellitus, 68 males and 14 females. There was also control study of 12 males and 12 females of similar age group. The diagnosis of diabetes mellitus was established after clinical and laboratory studies. Thereafter, their neurohumoral estimations were made for acetylcholine, catecholamines and also the cortisol in the blood as per the techniques discussed elsewhere. In addition, the lipid profiles were also studied for assessing the metabolic state in these people.

Results

CALECHOLAMINE

The results of our studies indicated that there was significant increase not only of total catecholamines, but also both in respect of adrenaline and noradrenaline in the diabetic mellitus patients. Such an increase of adrenaline, nor-adrenaline and total catecholamines ranged from 20 to 50% of the control in all the cases of diabetes mellitus. Further the increase in the catecholamines was more marked in younger diabetic patients (below 40 years) than the older ones (above 40 years). Similarly, we also observed that the more severe the diabetes the greater was the rise of catecholamines. Thus in mild diabetes, the total catecholamine was 296.3 μg/ml but in severe diabetes it increased to 355.6 μg/ml in comparison to control cases with

Table 6
Shows the levels of plasma catecholamine in deabetic patients according to severity
(From P.P. Rao, H.S. Bajpai & K.N. Udupa)
(Unpublished Data)

Cases	Adrenaline (Plasma) μg/ml	Noradrenaline (Plasma) μg/ml	Total Catecholamine (Plasma) μg/ml
Control	87.6	164.9	252.6
(24)	± 22.30	± 27.28	± 36.47
Mild Diabetes	97.3	199.0	296.3
(59)	± 20.71	± 23.88	± 35.58
	0.05	0.001	0.001
Severe Diabetes	118.7	236.9	355.6
	± 24.88	± 42.48	± 57.58
	0.001	0.001	0.001

only 252.6 μg/ml. This clearly shows that catecholamines play an important role in producing severity of metabolic disturbances which occur as a result of emotional stress (Table-6).

Another important observation that we could make was that there was a close relationship between catecholamines and the duration of illness. Thus, in the early period of onset (less than a year) the rise in the catecholamine was not found very significant. However, a significant increase in catecholamines was found after about 10 years of diabetic life. But, after 10 years the rise in the catecholamine contents was not found significant. Several explanations can be given as to why such a situation occurs with regard to catecholamine in diabetes. It seems that in the initial period of diabetes, say upto 10 years or so, catecholamine also adds to the increase in blood sugar and disturbance in the lipid profile. Thus, this is the stage at which one can reverse the disease process by using various measures for the reduction of catecholamines in the body including certain yogic practices. We have clearly observed that it is somewhat easy to produce reversal of this condition at this early stage by using specific measures. At the later stages, after 10 years or so, one can only give palliation by various antidia-

betic measures. Evidently after 10 years the body becomes adapted to the new situation of stress and hence catecholamine content becomes normalized to a considerable extent. All these facts clearly indicate that the emotional stress manifested in the form of excess of catecholamine plays a significant role in the initiation and maintenance of high blood sugar in the first few years of diabetic life and it is at this stage that one can try hard to reverse the process by adopting catecholamine reducing measures to be discussed later on.

ACETYLCHOLINE

When we studied the acetylcholine content in the diabetic patients, we found that there was no statistically significant difference between the controls and diabetics in the early stage of the onset of diabetes (controls 1.11+0.33 μg/ml RBC, 1 to 5 years duration—1.65+0.13 μg/ml RBC). From this observation, one can say that in the initial period of diabetes the body tries to pour out as much insulin as possible through the stimulation of parasympathetic nerves to combat the effect of catecholamines. However, later on there occurs the exhaustion of islets of Langerhans and hence they fail to overcome the effect of catecholamines. It appears that the role of parasympathetic nerve action seems to be much weaker than that of catecholamines and hence the diabetic state develops. However, if timely action is taken to strengthen the parasympathetic by yogic practice one can even prevent the development of this condition. However, this needs further study.

PLASMA CORTISOL

As already discussed another important parameter of stress, namely plasma cortisol was also measured in these patients to assess the level of stress which was operating in each case. To our surprise we found that in the early diabetics below the age of 40 years, the plasma cortisol was found raised by 65% of the normal which was statistically significant, whereas in the diabetics of older age who develop some type of adaptation, it was not raised significantly. Similarly, the plasma cortisol was

found raised (by 66%) significantly in the cases with severe diabetes (blood sugar more than 200 mg%) than in milder cases. In fact it appears that the degree of severity of diabetes can be seen closely associated with the rise in the plasma cortisol, and hence this has a prognostic value also. It was also found that plasma cortisol was much higher (68%) in those with less than 5 years; duration than with those with a history of 5 to 10 years; duration. Hence, it seems that as a result of bodily response to adaptation, plasma cortisol becomes gradually normalized unless the patients develop some complications when the plasma cortisol may be found raised again.

From all the above observations one can say that psychic stress plays an important role in the initiation and early course of diabetes in susceptible people especially in the 4th and 5th decades of life when a person is liable to face many such upheavels in life with gradually decreasing protective enzymatic response of the body. Thus, both catecholamines and cortisol were found raised in the first few years of the onset of the disease. Both these hormones significantly influence the protein, carbohydrate and lipid metabolism and antagonize the action of insulin. At the later stage of the disease and in older people when the response of insulin also becomes sluggish as a result of the development of autoimmune phenomenon in the islet of Langerhans, the secretion of catecholamine and cortisol also becomes less. However, whenever the disease takes a serious turn as a result of the development of some complications the catecholamines and cortisol are again found increased to cope with the situation. It should be remembered here that in such emergency situations the increase of these hormones is essential and beneficial to provide sufficient energy to the tissues involved. However, if such an increase is exaggerated or the response remains high for a longer period then it may produce harmful effects on the body. Therefore, a full study of all these factors of stress response must be made in each individual case before one can plan an appropriate treatment especially if the disease has taken a serious turn with some life threatening complications.

Management of Stress in Diabetic Patients

In all 20 cases were closely studied with regard to their stressful state in addition to the diabetic state. Their full physical and psychological history, clinical examination and laboratory investigations had been carried out as per standard methods. In the laboratory studies, blood sugar fasting and postpradial and serum lipid profiles were invariably done not only to establish correct status of the diabetic patients but also to compare with the results of follow up studies. Usually, all these patients were treated in the Diabetic Clinic of our University Hospital with oral antidiabetic drugs. However, this group of 20 patients was referred to Yoga Clinic after completing the investigations at the diabetic clinic. All these patients were in the age group of 25 to 45 years and of either sex and with a history of diabetes of 1 to 10 years duration. Some of them were fresh cases whereas majority of them had already received the oral antidiabetic therapy without any lasting relief.

All these patients were given standard yogic exercises (see Appendix). To start with, they practised only 4 simple postures and then gradually increased postures upto 12 by the end of 3 months. As the number of yogic postures increased, the requirement of drugs, if the patient had been taking them became less. Thus, at the end of six months most of the patients, especially with early diabetes, completely stopped the oral antidiabetic drugs (Fig. 70). Others with a history of diabetes of longer duration, who had also been taking antidiabetic drugs for a prolonged period, had to continue the drug therapy with much reduced dosage.

In addition to the clinical improvement and the feeling of well being, their psychological state also improved considerably following the introduction of yogic exercises. The mean fasting blood sugar came down from 152.45 mg% to 113.45 mg% within three to six months of starting yogic exercises. Similarly, the post-prandial blood sugar level also came down from 171.81 mg% to 171.45 mg% within the above period. However, there was no evidence of weight gain in these

BLOOD SUGAR LEVEL IN DIABETES BEFORE AND AFTER YOGA

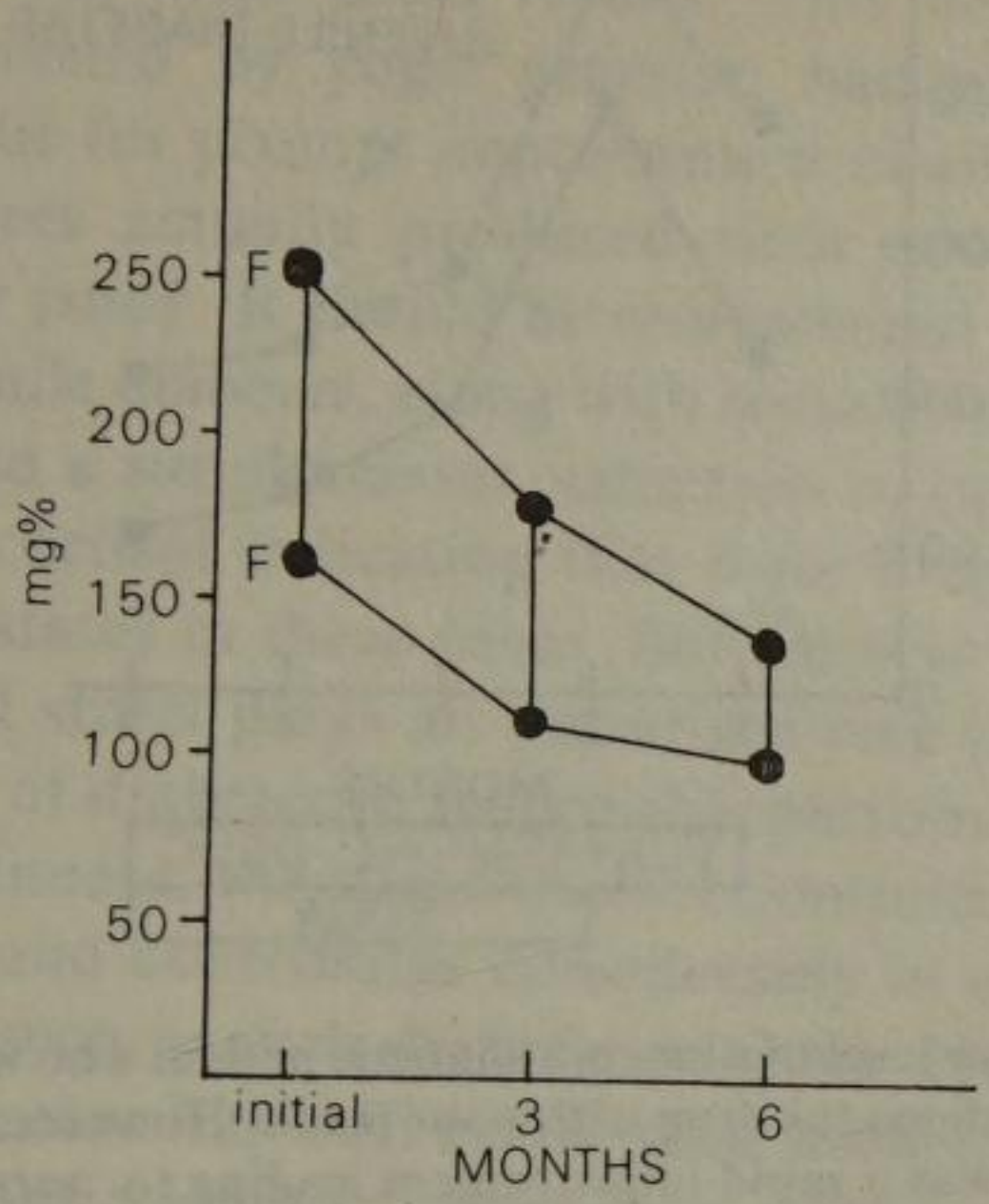


Fig. 70. A typical diabetic patient with a fasting blood sugar of 160 mg% and postprandial of 250 mg% could overcome his complaints fully towards the end of 6 months of regular practice of yogic exercise as mentioned in the Appendix.

patients. In fact their weight had slightly decreased at the end of the above period i.e. from 131.45 lb. to 129.00 lb. The neurohumoral studies indicated that there was a reduction of both the neurohumors studied, namely catecholamines and acetylcholine. Even amongst the two, the reduction in the catecholamines was much more significant especially in younger patients with shorter history of diabetes mellitus. In patients with successful outcome, the plasma cortisol level also became normalized at the end of six months. From all these clinical and laboratory observations one can say that in these cases of diabetes mellitus, with evidences of stressful state and corresponding increase in the neurohumoral pattern and plasma cortisol level, Yoga played an important role in helping the patients to recover from the abnormal situations and to regain their normal health. However, this matter needs further clinical confirmation as to which of these cases are most suitable for yogic treatment. One should remember that all these additioal yogic measures will have to be continued throughout

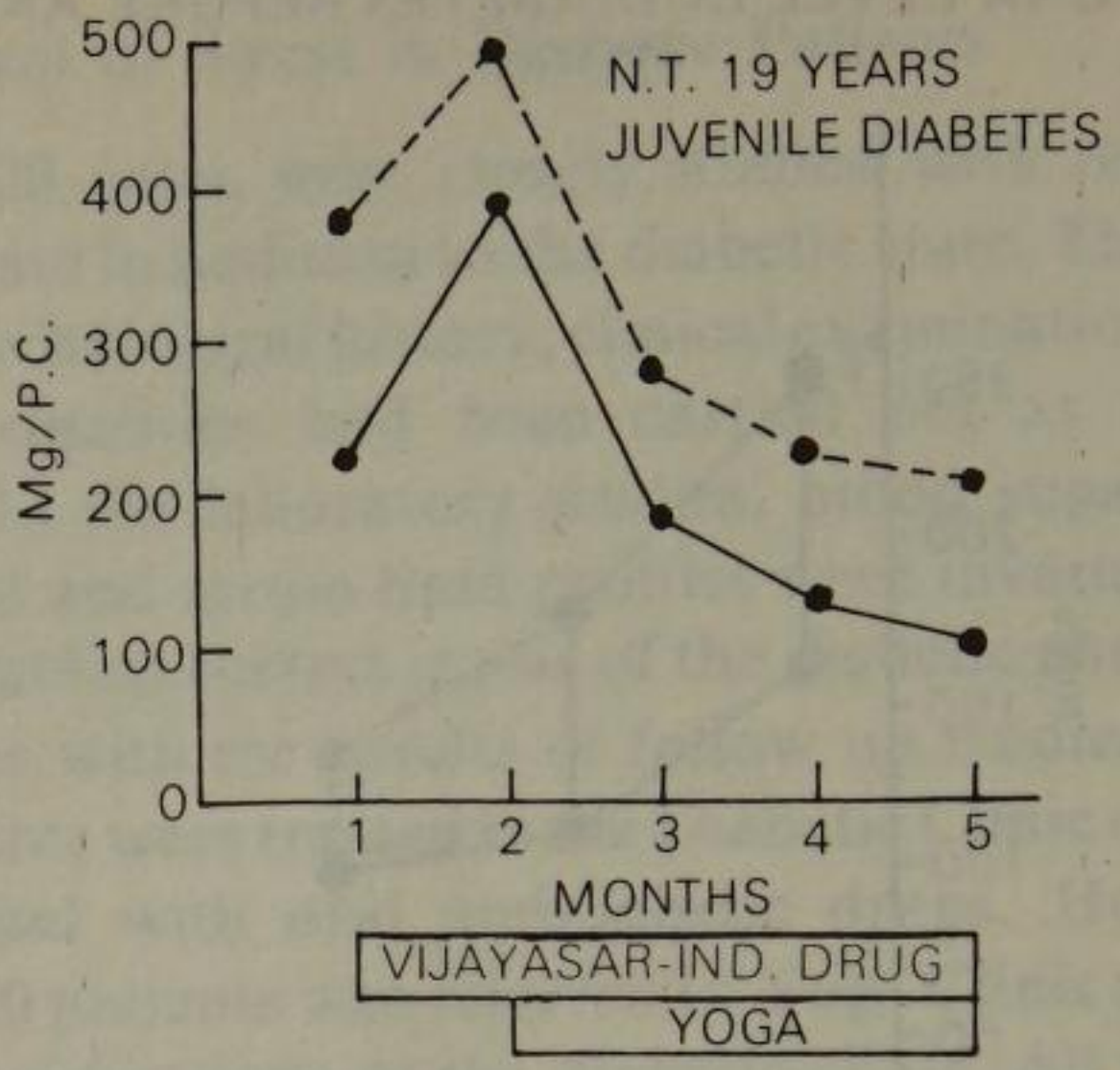


Fig. 71. Blood sugar level of a juvenilc diabetic patient who was at first put on "Vijayasar", an indigenous drug with poor result. However, when Yoga was added to it, there was a rapid improvement leading to normalcyin the next four months.

life if one wants to be free from this disease. We have observed that those who stopped yogic exercises after some time developed the recurrence of their condition. Hence, Yoga will have to be continued religiously throughout life if one wants to be free from this disease.

However, the patients of diabetes who are old (above 50 years) and who have had it for a long duration (above 10 years) and whose neurohumoral pattern has been normalized by the process of adaptation, do not usually respond to Yoga therapy. In all such cases Yoga therapy is contraindicated.

However our recent experience with five cases of juvenile diabetes is very rewarding. All these patients in the age group of 15 to 20 years had initially very high fasting blood sugar in the range of 400 to 500 mg%. Three of them had already received high dosage of insulin, with some improvement. All these patients were put on an indigenous antidiabetic agent "Vijayasar", Pterocarpus marsupium and regular yogic exercises mentioned above. This indigenous drug had been studied earlier by Dr. J. Ojha and his colleagues as an oral antidiabetic agent with good response (Fig. 71). In this, the decoction was

prepared from the trunk portion of this tree in the dosage of 10 gm twice a day with good results. This herbal treatment, further supported by yogic practice, had proved to be of immense value for prompt improvement in all the cases. How these measures actually produced such remarkable results needs further study. It should be remembered that in all these cases of juvenile diabetes, along with reduction of blood sugar there was also a simultaneous reduction in the neurohumors and plasma cortisol indicating that these drugs also reduced the stressful states in these cases. Suffice it to state here that psychological stress plays an important role in the initiation and progress of diabetes in susceptible persons. Once patients develop the disease, the stressful state continues to operate on these people and contributes considerably in causing various disturbances seen in such diabetic patients. However, gradually as the disease has well established itself in a person, the patient develops a state of adaptation, with normalization of

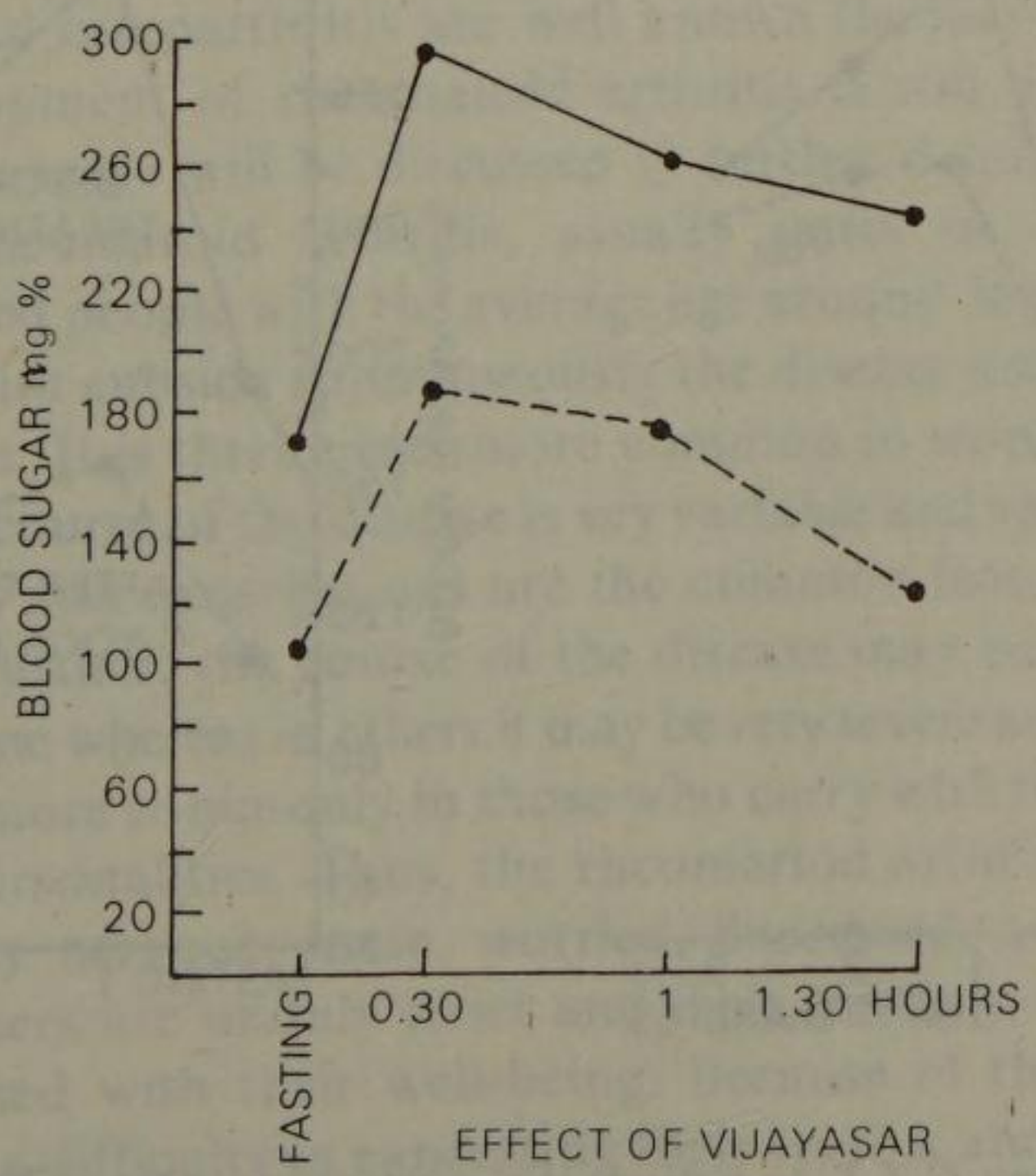


Fig. 72. Shows glucose tolerance test indicating the effect of the drug "Vijayasar" in the treatment of Diabetes Mellitus.

the neuohumors and plasma cortisol within a period of 10 years or so. By that period autoimmune phenomenon also develops in the islets of Langerhans leading to gradual reduction of cellular masses as a result of prolonged action of catecholamines. Once such a state develops, emotional stress does not play much role in the diabetic state and hence these yogic measures do not play much role in improving the diabetic state. However, these yogic measures will have some role to play in carbohydrate and lipid metabolism and hence they can be used as prophylactic measures to prevent the development of complication in these cases. Similarly, the herb 'Vijayasara' has given us very encouraging results when used alone (Fig. 72, 73). When it was used along with yogic practices in severe state of juvenile diabetes, the results produced were remarkably good. However, all these findings are being investigated further to put these newer measures on a firm footing.

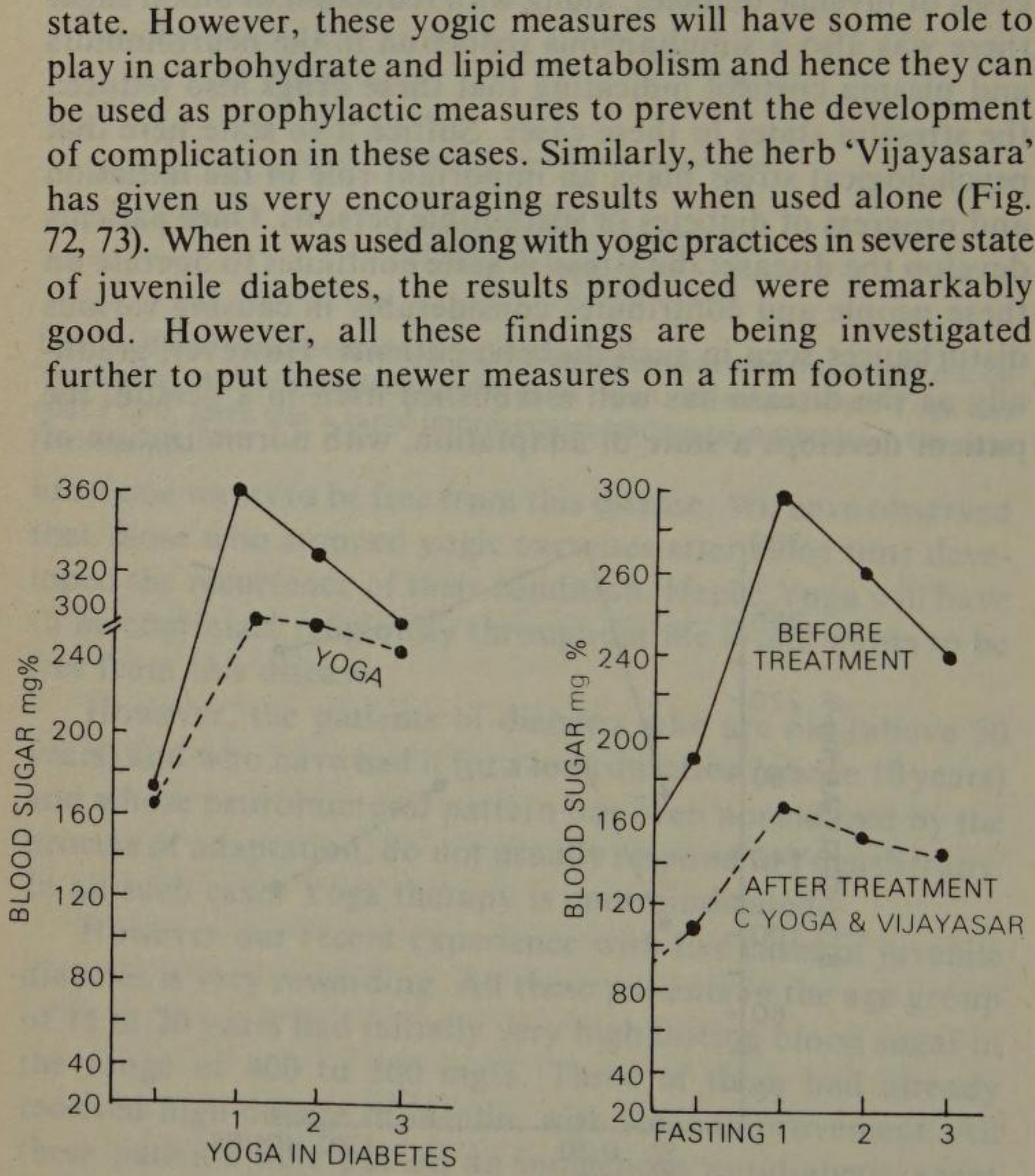


Fig. 73. Shows G.T.T. to indicate the comparative value of Yoga and Yoga cum "Vijayasar" in the treatment of Diabetes Mellitus. This clearly shows the efficacy of combined treatment.

CHAPTER 22

Stress and Arthritis

Chronic arthritis of various joints is one of the most disabling conditions to which human beings are exposed. It is more common in Western countries than in the tropical countries like India. The important diseases that fall under this category are gout, osteoarthritis and rheumatoid arthritis. Amongst them gout and osteoarthritis are commonly seen in old age whereas rheumatoid arthritis is the most difficult condition to treat and is commonly seen in young and middle aged persons. Whereas the physical factors responsible for the development of gout and osteoarthritis are well known the main cause for the development of rheumatoid arthritis is still not known. Hence, the same will be discussed in further detail here. The disease, rheumatoid arthritis, usually starts in young and middle-aged people with the average age around 36 years or so. If it does not subside spontaneously the disease may continue till old age. It is three times more common in women than in men. The course of the disease is vey variable and spontaneous remissions and excerbations are the common features of this disease. Further, the course of the disease may be extremely mild in some whereas in others it may be very severe and crippling. It occurs more commonly in those who carry with them certain specific personalities. Thus, the rheumatiod arthritis patients are usually nervous, tense, worried, depressed, and moody. Their fathers are unduly strict and their mothers are usually unconcerned with their well-being. Because of these factors they have a difficulty in expressing their sorrow and anger and hence the same always remain suppressed with them. Thus Pollotier states: "Arthritis patients who responded poorly to therapy and whose disease progressed, were noted to be more

anxious and depressed, more isolated, alienated and introverted than those whose disease took more benign course". Thus a person with personality traits of rheumatoid arthritis when exposed to severe stress and strain of life is likely to develop rheumatoid arthritis. Even in this condition when there occurs excessive psychic stress, the psychic centre becomes chronically excited leading to recurrent stimulation of hypothalamic region via limbic area which further causes stimulation of the sympathetic nervous system. In this condition, excessive outpouring of noradrenaline by the sympathetic nerve endings causes severe vasoconstriction especially around small joints of the carpal, metacarpal and phalanges. The writer had the unique opportunity of seeing a patient who used to get selective vasoconstriction around these joints whenever she was in great stress. At that time the surroundings of all these small joints used to become cold and blanched till the stressful situation subsided. This patient later on developed a mild type of rheumatoid arthritis which was successfully treated by certain psychotherapeutic measures. It seems that such a prolonged and repeated vasoconstrictive phenomenon following exposure to stressful situations might be responsible for triggering the development of autoimmune phenomenon as we have seen in cases of thyrotoxicosis. Thus, the prolonged and repeated ischaemia to the small joints followed by reactionary vasodilatation would release certain microsomal antigenic fractions of the synovial cells which would go to the regional lymph nodes to cause antibodies. When these antibodies come in contact with the damaged synovial cells, they cause severe inflammatory process causing a variable amount of inflammatory response depending upon the amount and severity of antigen-antibody reaction. Such a process can repeat itself as often as a person is exposed to different stressful situations. From these observations one can very well realize how psychic stress can cause such crippling disease of the joints in young people. It appears that in addition to personality traits, some genetic factor may also contribute to the

development of this disease, such as small joints of hands inherited by a person as "weak organs", due to which he becomes susceptible to get the disease on exposure to repeated psychic stress.

The further course of this disease varies from person to person. In some there may be slow and steady progress of the disease due to which there occur small swellings in the joints with some incapacity to use the joints properly. In these cases the disease is almost self-limited, whereas in others (about 10%) it may take a serious turn and may become a rapidly destructive and crippling disease leading ultimately to confinement to a wheel chair or bed. In still others it may have a very mild course so that the patient may rarely need any medical attention. It should be remembered that in all these three groups with variable courses, the psychological stressful factors play a dominant role in the initiation and progression of the disease.

Once the disease starts, the non-specific autoimmune type of chronic inflammation with lymphocytic infiltration sets in the synovial membrane of the given joint. Then the inflammed synovial tissues creep into the joint and involve the articular cartilage in the inflammatory process. Thereafter, it not only destroys the cartilage but also the bones that take part in the joint. Gradually, the entire joint becomes a mass of granulation tissue with variable amount of scar tissue with no ability to move the joint. Because of these extreme possibilities one should be able to diagnose this condition at its early stage and treat it effectively both physically and psychologically.

Treatment

So far the treatment of this condition has been most unsatisfactory, because its etiology is not clear. It has been considered as an autoimmune disease and has been treated symptomatically with a prolonged use of cortisone. However, the cause of development of autoimmune phenomenon selectively in the joints, especially the small ones is the most difficult problem to understnad. It is only recently when we started

studying various stress disorders, that we could explain how psychological stress could cause this disease in the joints.

Corticosteroids do help to reduce the inflammatory process in a large number of cases, though they are not capable of arresting the course of the disease for a long period. Therefore, as the disease progresses, higher dosage of cortisone is needed, which may result in many complications, in the early stages of the disease and also for alleviating the symptoms in acute exacerbations of the disease.

It would be seen that a major remedy for the relief of these patients would be a regular practice of yogic postures. We have been greatly impressed by the remarkable improvement in their conditions when they are recognized and treated with yogic practice at their early stage. Thus in all we have treated nearly 50 cases of rheumatoid arthritis of various joints including those of the spine with uniformly good results in almost all the cases within a period of six months. However, all these patients were advised to continue with their regular practice of Yoga throughout the duration of their life. In the beginning the patients are reluctant to take up the practice of Yoga in view of their painful joints. However, once they become convinced of its utility they religiously carry on all the yogic practices regularly. Once they start such a practice their daily requirement of analgesics and cortisone gradually becomes less and some of them stop taking the medicines in as early as 3 months, whereas others continue the medicines till about six months when they get full recovery. Those whose condition has advanced will also derive considerable benefit by these yogic practices, even though they will have to continue with their drugs for a longer period with some reduction in dosage. Thus out of 50 cases 48 had complete symptomatic improvement in their condition whereas two did not continue the treatment for a longer period. Thus, for rheumatoid arthritis regular practice of yogic postures would greatly help the patients to overcome their disease to a considerable extent. These yogic postures presumably help them by increasing the cortisone output from the adrenal cortex. Such an increase in the endogenous production of cortisone

might be playing an important role in giving relief to these patients. Further, it is also well known that yogic practice increases the acetylcholine content of the cerebral cortex, which ultimately produces tranquility of the psychic centre of the brain. This leads to reduction in the severity of stimulation of hypothalamus and the sympathetic nerve endings even though they are exposed to many stressful situations. Thus reduction in the severity of stress response and an increase in the cortisone output may be the main factors which are responsible for giving prompt relief to the patients after the regular practice of yogic postures (see Appendix). Hence, they are recommended to all such patients, especially if they are at an early stage of the disease.

CHAPTER 23

Anxiety Neurosis

Neurosis is a common psychosomatic disorder which can be subdivided into anxiety neurosis, hysterical neurosis, obsessive-compulsive neurosis, phobic neurosis, depressive neurosis, and neurasthenic neurosis. Here, we are mainly concerned with anxiety neurosis which is commonly seen as a result of excessive psychosomatic stress. The symptoms of this condition often include anxiety and exaggeration of various bodily functions to cope with anxiety and stress. Anxiety means feeling anxious, highly tense and panicky with a vague apprehension that something terrible is going to happen to one. Sometimes, such feeling is accompanied by some somatic complaints such as tightness in the chest, difficulty in swallowing or breathing etc. As a result of too much of anxiety a person exposed to stress and with genetically susceptible psychosomatic constitution, develops various symptoms involving all the systems. Thus there can be tachycardia, pain in the chest, tension headache, pain in the limbs and joints, tremors in the hands and fingers etc.

ETIOLOGY

Various studies have indicated that hereditary factors also play some part in the genesis of anxiety neurosis. This condition is found more frequently in families with a background of similar symptoms. Further, experience of emotionally disturbing factors in early life may play an important role in the genesis of this disease, such as sudden severe fright or other similar events. Children neglected by their parents or children who have been given too much of protection by their parents are more liable to get this disease when they reach adulthood.

At that time any painful events such as bereavement, reverses in love affair or disappointments in one's career may cause a susceptible person to get severe anxiety which would severely interfere with his ability to cope with the unfavourable environment. Therefore he or she gradually develops various features of this disease.

PSYCHOLOGICAL ASPECTS

Anxiety is an experience characterized by fearful anticipation of an unpleasant event in the future. This should be differentiated from fear, since anxiety is an individual's response to a danger that threatens from within, whereas fear is defined as the reaction of a person to a real external danger. Many times, both anxiety and fear may be present in a given situation. But in anxiety neurosis internal danger plays an important role, with anxiety playing a central role in the functioning of psychic apparatus. In the early years Sigmund Freud observed abnormalities in the sexual life of his patients as the fundamental cause of the arousal of anxiety. According to him excessive discharge of sexual energy or failure to achieve the normal discharge of sexual activity may lead to the development of anxiety neurosis. However, in recent years it has been agreed that anxiety is found as a symptom of all forms of emotional illness. In fact, anxiety is an indication that something is disturbing the internal psychological harmony and if one cannot control the process of his anxiety one is sure to become a victim of anxiety neurosis. Many times the patient himself is not fully aware of all the psychological changes taking place within himself and also the various causes for developing such changes. It is conflict between the factors of environment and the personality of an individual which ultimately leads to the development of anxiety neurosis. In such conflicting situations usually matters related either to sex or ego would play dominant role. Hence, a detailed psychological history will have to be prepared to elicit all the informations so that proper treatment can be planned.

PHYSIOLOGICAL CHANGES

Various recent studies have indicated that in anxiety neurosis there is an excessive outpouring of all the neurohumors. In the initial period, because of excessive stimulation of psychic and limbic cortex, there is too much outpouring of acetylcholine from these regions of cerebral cortex (Fig. 74). But soon the autonomic nervous system is also stimulated, especially the sympathetic nervous system leading to too much of turnover of adrenaline and noradrenaline. When these neurohumors circulate in the blood they produce a series of changes in the functions of different organs, such as tachycardia, hypertension, tremors, excessive perspiration etc. Because of the interference with circulation in the skeletal muscles there occurs anaerobic cellular metabolism leading to excessive liberation of lactates into the blood. All these physiological changes occur as a consequence of excessive liberation of the above

R.B.C. ACETYLCHOLINE AND R.B.C. CHOLINESTERASE IN CASES OF ANXIETY NEUROSIS

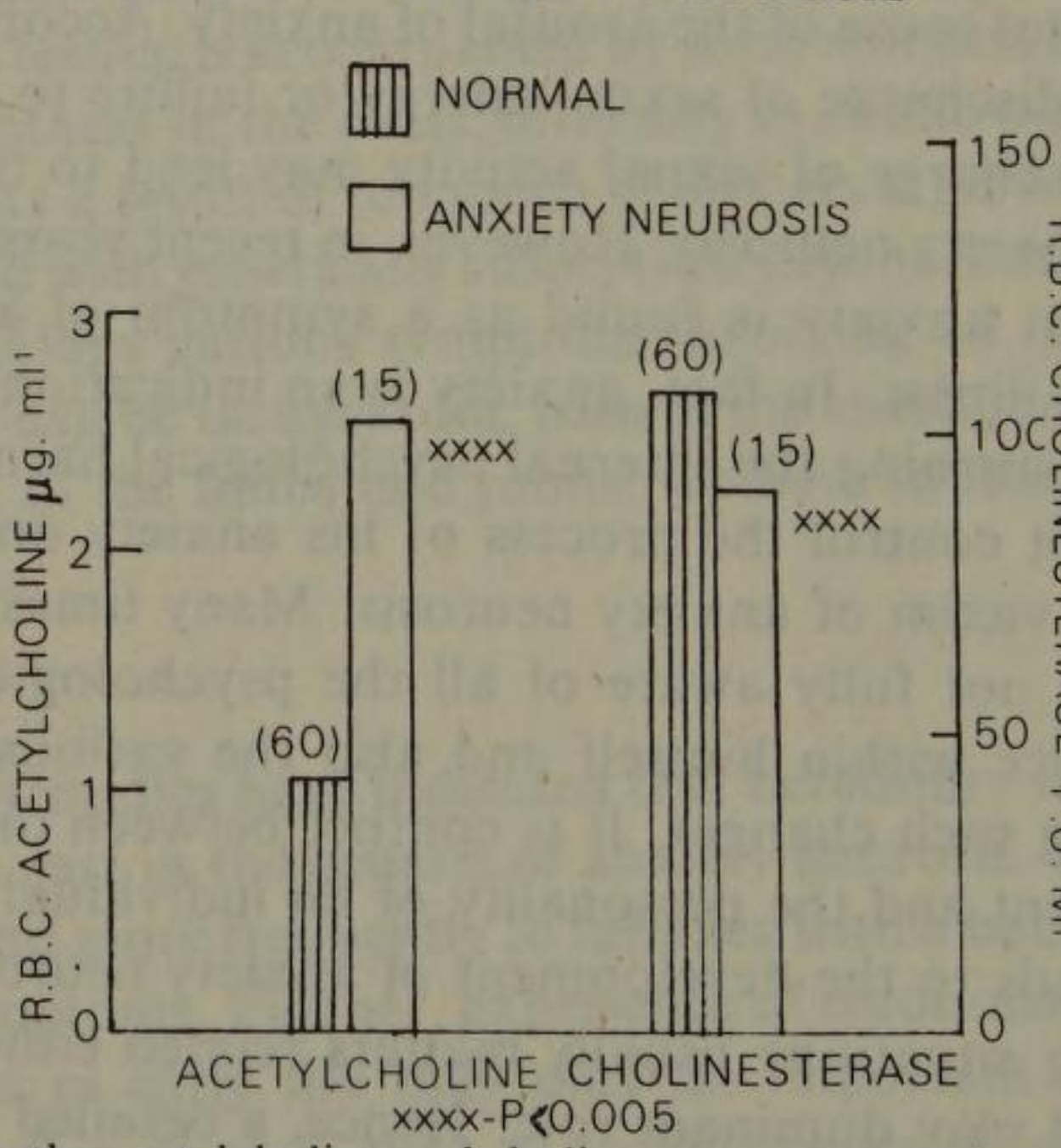


Fig. 74. Shows the acetylcholine and cholinesterase content in anxiety neurosis. Here one can see a marked increase of acetylcholine with a relative decrease of cholinesterase of blood in these cases. Because of this a person becomes hypersensitive to environmental disturbances.

stated neurohumors. This will give rise to many clinical features which may resemble those of some organic diseases like angina pectoris, thyrotoxicosis, etc. However, by careful studies and investigation one can differentiate this condition from others.

CLINICAL FEATURES

Anxiety neurosis may develop suddenly, often in severe intensity appearing against relatively normal environment or it may begin slowly with general feeling of tension and nervous discomfort with periodic exacerbation according to circumstances in life. Usually, such patients do not give a full history of any internal conflict with the family or other similar worries which would give rise to stressful situations. Sometimes some environmental event may stimulate the development of internal conflict. One precipitating cause found frequently is the death of a near relative from myocardial infarction. Following such a sad demise in the family, the susceptible person develops cardiac symptoms of an acute anxiety neurosis along with apprehensive conviction that he has the same disease as the person who has died.

In acute anxiety neurosis, there are violent attacks of palpitation, flushing of the face, and pulsations that one feels in the neck and head. Because of this, the patient usually remains in a state of panic thinking that he has had a heart attack. His anxiety becomes so much overwhelming that he feels some imminent catestrophe may ruin him completely. He fearfully anticipates that he may drop dead by a heart attack at any moment. In order to overcome all these anxieties, the patient feels that he must do something and he runs, hides or gets way to save lhimself from the internal terror without much success.

During the acute attack, the patients get severe palpitation, tachycardia, chest pain, respiratory distress, and the experience of panicky dread as the main symptoms, but other symptoms may appear along with those such as dizziness, fainting, cold perspiration, trembling in the extremities, pain in the epigastrium and other similar features. Psychologically,

the patient is hardly in a position to think or act intelligently and he often complains that his mental state has become confused and clouded. It should be remembered that these attacks of neurosis come to a patient all of a sudden and remain for a variable period of time. Sometimes, they may disappear completely, but many times an attack lasts for a longer duration due to which the patient remains in a state of persistent anxiety punctuated by waves of utter panic and terror.

CHRONIC ANXIETY STATE

In a chronic anxiety state, many of the symtoms seen in the acute stage remain in a milder form for a prolonged period. In such cases, the patient may not be able to tell us how and why he remains anxious. However, some of them may be able to identify the environmental troubles such as marital tension, excessive pressure of work or similar other disturbances. In this condition the patient complains of being nervous, tense and irritable. He may have difficulty in getting sleep at night, and may get tired quickly during the day. He may have muscular tension or pain especially in his neck and back. He sweats easily, particularly in the palm and feet and often gets dryness of the mouth. He feels shaky and gets fine tremors in the fingers. The patient frequently complains of lack of power of thinking and concentration, due to which he is unable to carry on his allotted duties in his occupation. In women, disturbed menstruation is a common feature.

On examination, there is no definite, positive finding, except rapid pulse rate, elevated systolic pressure upto 140 to 150 mm Hg. Pulse is regular without any extra systole. Electrocardiogram is usually within normal limits, though in an acute attack one may get inversion or T wave in lead I, II & III. Similarly, EEG remains within normal limits although occasionally as a result of severe anxiety, the alpha wave may be disturbed especially in the frontal areas.

DIAGNOSIS

For arriving at a correct diagnosis one will have to prepare

a detailed history of the patient's exposure to any type of acute or chronic stress. Many times the patient may not remember any such conflicting mental situation to which symptoms referable to some organs such as heart or thyroid gland, may be attributed. In order to exclude the disorders of these organs, a thorough physical examination is also conducted. Similarly various investigations such as ECG, EEG, X-Ray of the chest and gastrointestinal canal may be called for, if required.

In the differential diagnosis, apart from differentiating the conditions from various psychiatric disorders, it should also be differentiated from coronary artery disease and thyrotoxicosis. Coronary artery disease is suspected because of the presence of symptoms of chest pain and respiratory distress in acute attacks of anxiety neurosis.

CASE HISTORY

A 44 year old man was rushed to the hospital because of tachycardia, palpitation, chest pain and slight dyspnoea. He was admitted to the hospital with the diagnosis of myocardial infarction. However, repeated electro-cardiographic examinations and also various biochemical studies did not reveal any positive evidence of myocardial damage. In spite of this, the patient was found highly apprehensive and anxious and was always worried about an anticipated heart attack. However, on a detailed enquiry, it was found that the disease started after the patient had seen one of his friends suddenly getting heart attack with immediate death. This had produced such as serious effect on the mind of the patient that since then he had been having repeated attacks of palpitation, tachycardia and precordial pain. Thereafter, he was diagnosed as a case of anxiety neurosis and was given prolonged course of tranquillizers, psychotherapy, Yoga therapy with complete subsidence of all the clinical features in the next six months.

THYROTOXICOSIS

Many times patients of thyrotoxicosis are confused with anxiety neurosis, because in both diseases one can get anxiety,

restlessness, sympathetic overactivity and feeling of exhaustion. However, in anxiety neurosis tachycardia diminishes markedly when the patient goes to sleep, whereas in thyrotoxicosis tachycardia persists even during sleep. Further, the thyroid function studies will help to arrive at correct diagnosis. Sometimes anxiety state may coexist in thyrotoxicosis. In such cases one will have to treat both the conditions together.

It seems that the main cause of attacks of anxiety neurosis is a sudden increase of adrenaline and noradrenaline leading to all the symptoms of tachycardia, palpitation, tremors, apprehension and elevated blood pressure. Hence, any condition which has such an episode will have to be differentiated from this.

Treatment

PSYCHOTHERAPY

The most important measure to overcome this disease is psychotherapy. The patient should be allowed to tell the whole story and the main cause of his anxiety. The physician should give repeated assurances and encouragement to the patient to overcome his unrealistic fears and face the situation boldly. If the situation does not improve, the patient may even be asked to change the environment in order to reduce the stress. This would many times help in overcoming the trouble permanently.

YOGA THERAPY

One of the most effective treatments for the management of anxiety neurosis is the practice of yogic exercises. We usually prescribe eight standard yogic exercises and also *Pranayama* which can be learnt by the patients within a period of 2 to 4 weaks. Thereafter, they independently carry on these exercises at home regularly in the morning. Within three months the patient gets over the entire symtoms and feels much better and more confident in himself and also in his work (Fig. 75). Because of this he gradually recovers from all his symtpoms.

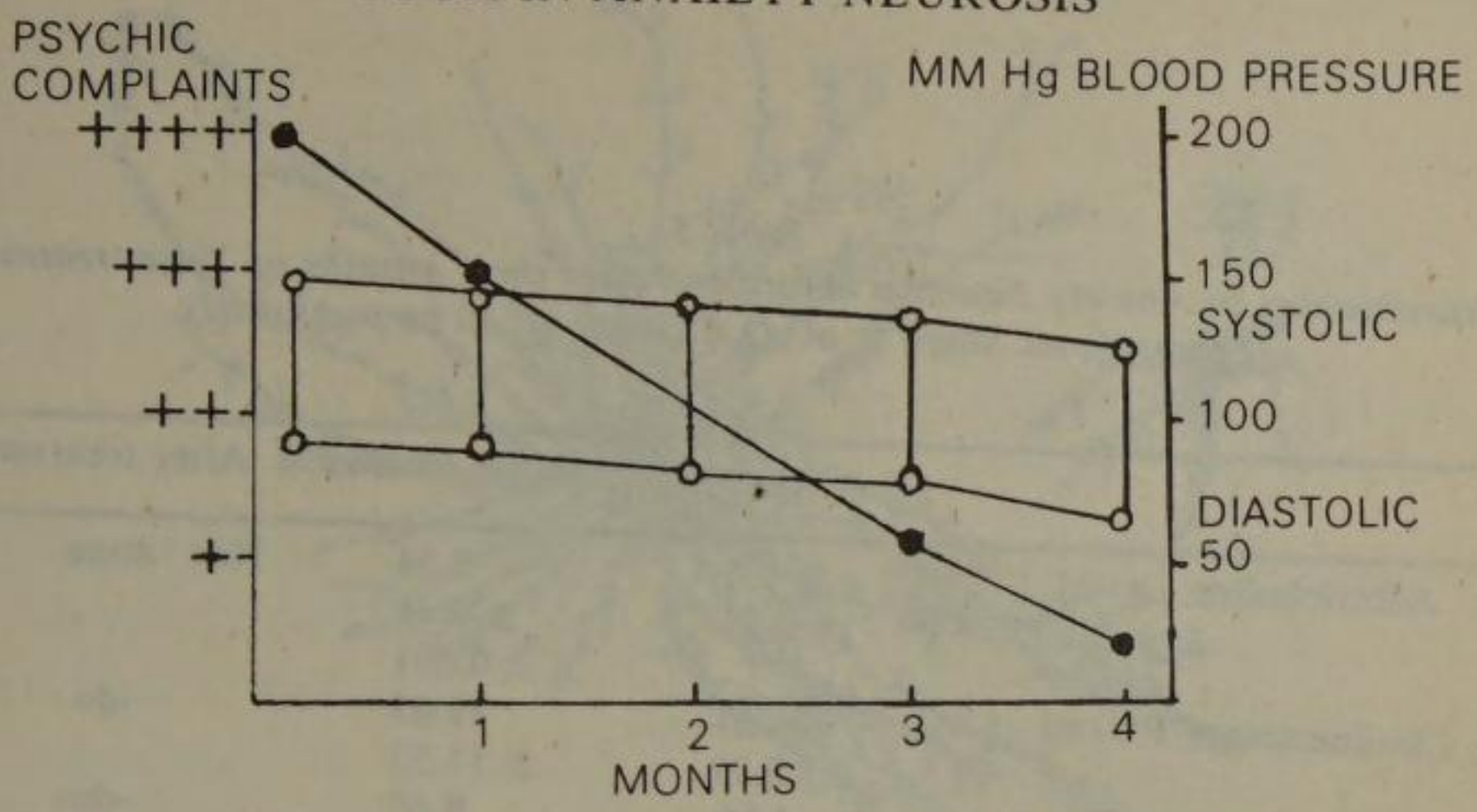


Fig. 75. Shows the gradual improvement in psychic complaints and a normalization of blood pressure after yogic practice. The improvement in the psychic disturbance is remarkably quick whereas the improvement in signs like B.P. is gradual.

The neurohumoral studies also indicate a reduction in RBC acetylcholine, and catecholamine both in blood and urine (Table-7). Because of these changes, tachycardia and palpitation become less severe. The systolic blood pressure also comes down. The anxious feeling, restlessness, and sleeplessness also decrease and the patient ultimately overcomes his troubles. However, one should remember that the patient will have to continue with his yogic practice throughout his life if he wants to be free from this illness. In all, it takes about 15 to 20 minutes to carry on a set of standard yogic exercises and it is stated that it would act as a psychologial immunizing agent to prevent the development of any stressful condition.

MEDICAL TREATMENT

In the acute phase of anxiety neurosis, one will have to resort to medical measures to get over the acute features of illness. Generally, the minor tranquilliżers such as meprobomate and diazepam are very useful to get over the distressing symptoms such as sleeplessness. Similarly, beta adrenergic blocking agents such as propranalol (Inderal) 40 mg two to three times a day will help to neutralize the effect of catecho-

Table 7.
Neurohumors in Anxiety Neurosis before and after three months of Yoga treatment
(From Nimai Singh et al. Q.J. Surg. Sc. to be published)

	Control	Before treatment	After treatment
1. Acetylcholine μg/ml	1.4 ± 0.37	2.54 ± 0.46 0.001	Not done
2. Cholinesterase PU/ml	106.00 ± 15.37	89.07 ± 11.53	-do-
3. Serum PBI Mg%	5.96 ± 2.52	9.67 ± 1.23 0.001	-do-
4. Plasma Cortisol μg%	24.32 ± 11.31	36.82 ± 5.73 0.001	-do-
5. Urinary Adrenaline μg/25 mg Creat.	0.225 ± 11.31	0.308 ±0.114	0.275 ± 0.141 0.025
6. Urinary Noradrenaline μg/25 mg Creat.	0.711 ± 0.277	1.116 ± 0.210 0.01	0.789 ± 0.241 0.01
7. Urinary V.M.A. μg/gm Creat.	1.98 ± 0.42	3.76 ± 1.86	2.55 ± 0.80 0.025

lamines on the cardiovascular systems. Amongst the medicinal herbs *Shankhapushpi* (Fig. 76), *Brahmi* (Fig. 77) and *Ashwagandha* (Withania somnifera Dunal) have been found to be extremely valuable agents to reduce the clinical features and also restore neurohumoral response to normalcy (Fig. 78, 79). Thus in a recent study conducted by Dr. R.H. Singh and P.C. Malaviya one can see distinct advantages of the synthetic ones and hence there is a great need for pursuing further studies in this field.

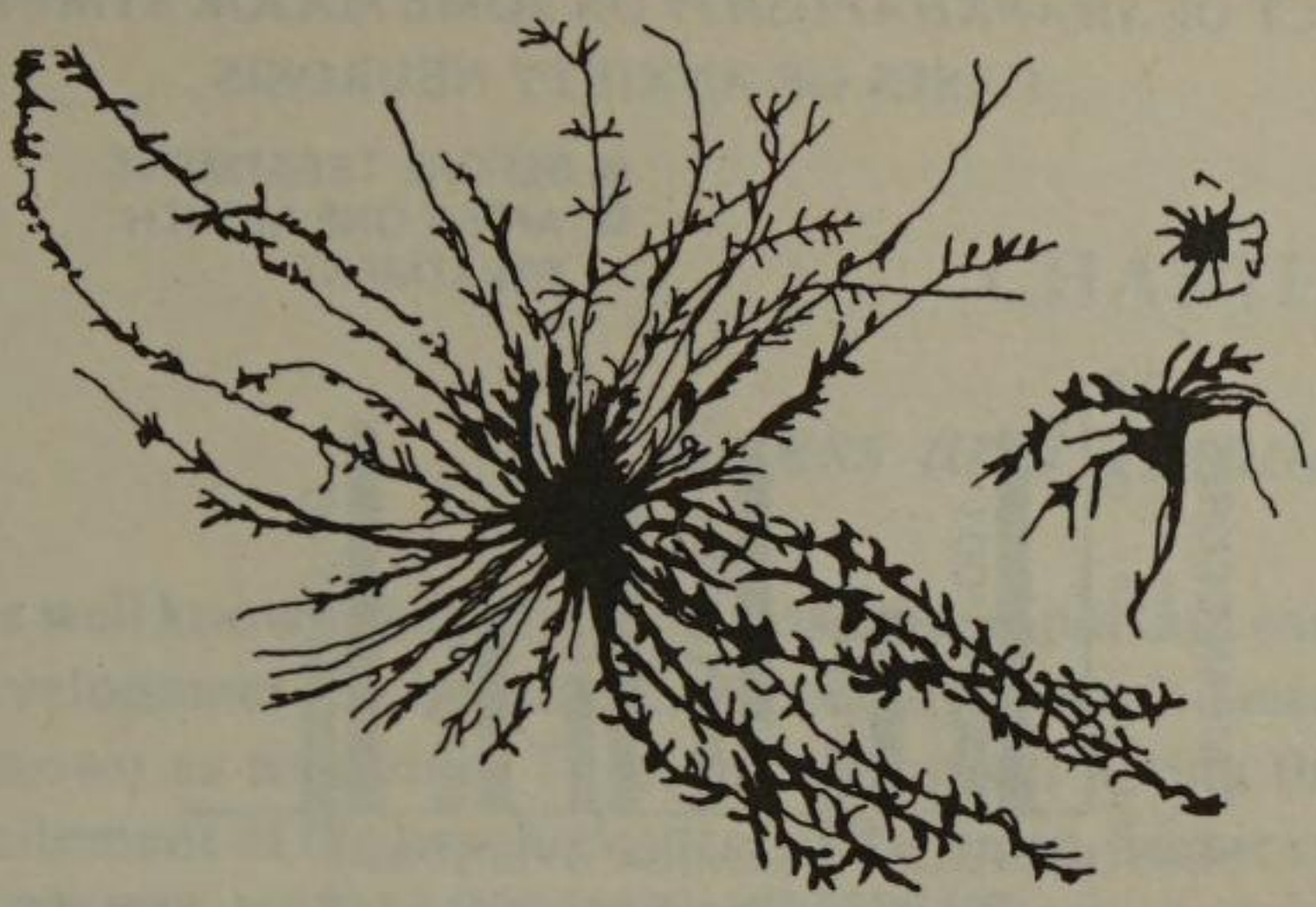


Fig. 76. Picture of the herb *Shankhapushpi* (C. Pluricaulis) which is considered to be one of the best psychotropic drugs described in Ayurveda.

Fig. 77. Picture of the psychotropic drug *Brahmi*.

EFFECT OF *SHANKHAPUSHPI* ON SOME MAJOR SYMPTOMS IN CASES OF ANXIETY NEUROSIS

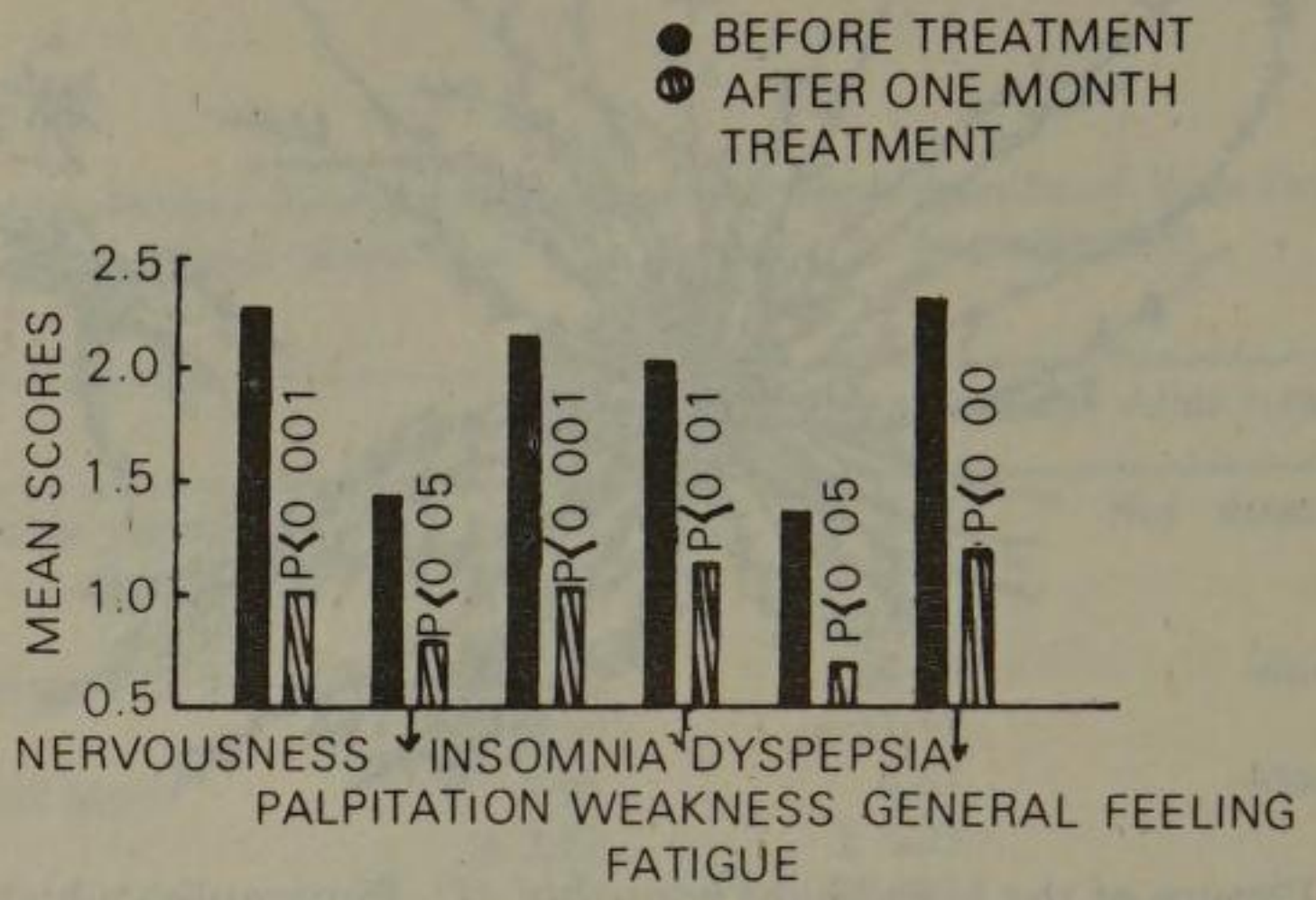


Fig. 78. Shows marked effect of *Shankhapushpi* on the clinical symptoms of anxiety neurosis, especially nervousness, palpitation, insomnia etc.

EFFECT OF *SHANKHAPUSHPI* (C. PLURICAULIS) ON THE NEUROCHEMISTRY OF WHOLE BRAIN TISSUE IN RATS

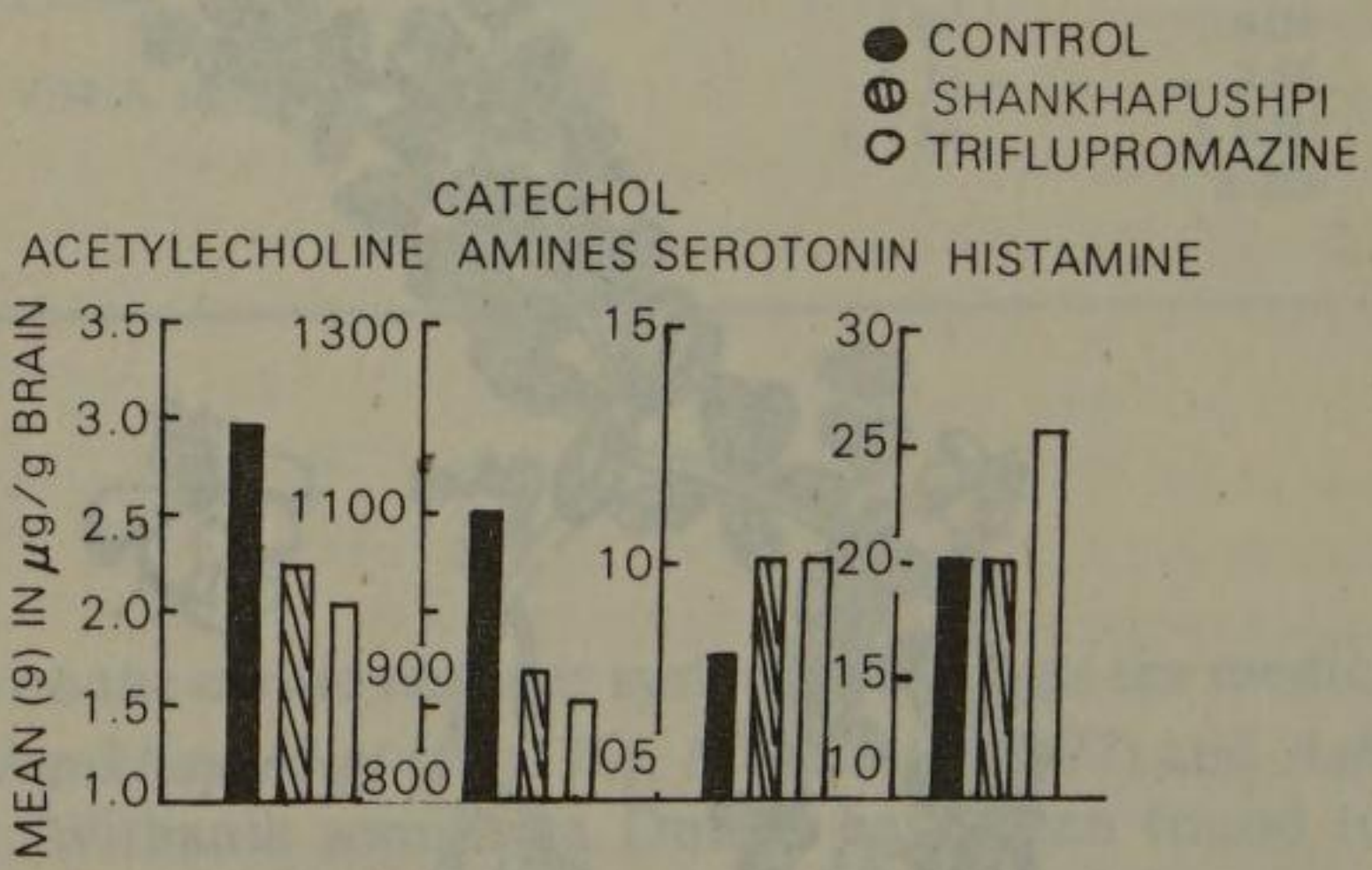


Fig. 79. Shows the effect of *Shankhapushpi* in the biochemistry of the whole brain tissue in rats. There is marked decrease of acetylcholine and catecholamines after the use of the above drug with slight rise of histamine.

CHAPTER 24

Stress and Headache

It is well known that psychic stress is an important cause for the development of headache, especially tension headache, also known as migraine. Thus, psychic stress acting through the excitement of the psychic centre of the brain, limbic system, hypothalamus and autonomic nervous system causes vaso-consrtiction alternating with vasodilatation of the arteries and arterioles of the head, giving rise to headache. Simultaneously with this, there occurs an increase in the tension of the muscles of head and neck leading to further increase in the severity of headache. It should be remembered here that headache does not usually occur when there is actual emotional tension, accompanied by vasoconstriction as a result of increased activity of the sympathetic nervous system. The pain becomes aggravated as a result of abnormal vasodilatation which is due to the local liberation of histamine in excessive quantity. Such a prolonged vasodilatation causes severe headache in the region of the head.

In migraine in addition to attacks of severe headache, there may be additional constitutional symptoms such as vomiting, biliary colic, angina pectoris, paroxysmal tachycardia or urinary frequency. These conditions are also due to psychogenic stress and hence they further cause difficulty in the proper management of these cases. Further in true migraine at the onset of attack in almost all the cases headache affects just one side of the head. In some cases it may later generalize and involve both sides. It is usually preceded by certain prodromal symptoms like visual abnormalities, nausea, vomiting, weakness etc. This is followed within one to two hours by the onset of actual pain of headache starting in one area of the forehead

which is usually throbbing or pulsating in nature. Within the next one to two hours from the onset the headache reaches its peak and then gradually subsides within 4 to 5 hours.

It is now well established that in tension headache and migraine psychic stress plays an important role. Feeling of anxiety, nervous tension, anger and some other repressed emotions are some of the psychic factors seen very often in these cases. With regard to the psychic personality of migraine, Pailetier states: "According to personality tests a typical migraine sufferer is perfectionist, ambitious, rigid, orderly, excessively competitive and unable to delegate responsibilities. Such a person often has an attitude of chronic resentment and may experience profound frustration at not being able to live upto his unrealistic ideals."

Apart from emotional stress and susceptible personality, sensitivity to certain foods also plays an important role. Some food articles, such as old cheese, which contain excess of serotonin are more liable to cause the attack of headache. Such headaches usually start in middle aged people, more often in women than men, and subside when they reach old age. In their management a number of drugs have been tried in addition to the free use of common analgesics such as Aspirin and other similar drugs. As a vaṣoconstrictive measure Ergotamine tartrate is also being tried with some temporary relief. Caffine and Belladona preparations are also being tried with limited benefit.

Recently, the use of meditation, Yoga and biofeedback training has greatly helped these patients to get over their trouble permanently. By following any one of these methods one can attain a deep relaxation both of body and mind leading to complete alleviation of headache or prevention of the recurrent attacks of migrainic headache. In fact these relaxation measures work more efficiently than any of the medications or tranquillizers discussed earlier. In addition to this, control of various dietetic factors also helps greatly in overcoming the attack permanently. By following these measures we had an opportunity of treating six patients with intractable tension

headache, who could not get over the trouble in spite of many medical measures. As a last resort they were referred to our Yoga Clinic. All the six were middle aged male persons with a history of attacks of headache for a period varying from 2 to 4 years. Treatment with Caffergot, Bellargol or tranquillizers did not give them any relief. All these patients were then admitted for Yoga therapy consisting of 8 yogic postures to be practised everyday (see Appendix). All these six patients completely recovered from their illness at the end of three months. However, they were advised to continue regular practice of Yoga throughout the rest of their lives. We have a follow-up of all these six patients for a period of 18 to 24 months and it is gratifying to note that none of them had any further attack of headache. From these observations one can say that yogic practice has a great role to play in relieving tension headache and migraine as is evident from the six patients whom we have been able to treat. However, further study in this regard is needed to fully confirm these findings.

CHAPTER 25

Stress and Cancer

Ever since the Nobel Laureate Charles Huggins demonstrated the role of hormones in the development of cancer of the prostate and breast, a large number of studies were conducted to investigate the exact mechanism of action of these hormones on the normal and abnormal cell growth of the body. Burnet, another Nobel Laureate, on the other hand, postulated that one develops cancer as a result of immunological failure. Therefore, it could be hypothesised from these observations that excess of certain hormones especially from the adrenal gland may suppress the immunological barrier of certain tissues and organs of the body, and may, thus, make them more susceptible to cancer.

Amongst various hormones, cortisone plays an important role in producing immunological depression if released in excess. Release of cortisone occurs most commonly after any type of psychosomatic stress. In fact, in such situations, both catecholamines and cortisone are released in excess, which together produce changes in the organs and tissues.

In our earlier studies, we observed increased plasma 17-hydroxy-corticoids in breast cancer patients. Further, a direct correlation between the stages of the disease and the increase in the plasma 17-hydroxy-corticoid was also noted. Thus, in stage I of cancer, the levels of plasma 17-OHCS were much less as compared to stage II and III. In addition, recently certain experimental studies have also provided clues in favour of stress as an oncogenic factor.

Considering these facts, we decided to investigate the circulating catecholamine levels and the catecholamine metabolism in the thyroid and adrenal tissues in experimentally induced

thyroid tumour bearing rats. The catecholamine metabolism was assessed in terms of its synthetizing enzyme i.e. adrenal PNMT activity and the degrading enzymes, MAO and COMT activity. Simultaneously, in clinical cases suffering from carcinoma and sarcoma the stress reaction was also evaluated in terms of circulating and malignant tissue, catecholamine and histamine levels. Besides this, the plasma cortisol levels were also determined in all these cases.

EXPERIMENTAL

Eighteen albino rats (100-150 gm) of both sexes were used. Six of these were given 0.1 ml of 0.9% normal saline i.p. once daily and served as control. In the rest 12 rats thyroid tumours were produced as per method of Milcu. In this method, hemithyroidectomised rats were fed 5 mg of carbimozole (suspended in water) once daily. This treatment was started seven days after hemithyroidectomy, for an alternating period of 30 days' treatment and 30 days' pause for 4 months. Simultaneously, these rats were also injected hydrocortisone 2.5 mg/100 g body weight i.p., 3 times a week, for the above period of 4 months. All these animals were kept under the usual normal laboratory conditions.

At the end of the experiment, under nembutal anaesthesia (25 mg/kg body weight) blood was collected through cardiac puncture. The serum was utilised for the assay of adrenaline and noradrenaline. Thyroid and adrenal glands were also dissected out. A portion of the thyroid gland was fixed in bouin's fixative. Paraffin section of 6 μ was cut and stained with haematoxyline and eosin. The remaining thyroid and adrenal glands were utilised for the assay of catecholamine COMT, MAO and PNMT.

Clinical

In the present clinical study, 32 cases of carcinoma and 12 cases of sarcoma of either sex were included. Their age ranged between 17 and 80 years. Detailed clinical history with particular reference to any evidence of stress prior to the development

of the disease was noted. Blood was collected in the morning from the antecubital vein in the supine position under fasting condition. The blood samples were utilised for the assay of plasma catecholamine, plasma cortisol and blood histamine. The malignant tissues obtained either through biopsy or total excision were used for the determination of catecholamine and histamine contents. Ten cases suffering from non-malignant conditions were put under the same protocol and served as controls.

RESULTS

Experimental

No significant change in the serum catecholamine level could be observed between the thyroid tumour bearing rats and the controls.

The thyroid MAO activity did not show any significant change between the thyroid tumour bearing rats and the controls. No COMT activity could be detected in the neoplastic thyroid tissue.

The adrenal catecholamine content showed a significant decrease in the thyroid tumour bearing rats as compared with the controls. Similarly, a significant fall in the MAO activity in the adrenal was observed. However, PNMT and COMT could not be detected in the adrenals of the thyroid tumour bearing rats.

Histologically, at the end of the experiment the thyroid showed marked pleomorphic cellular changes indicating its being anaplastic carcinoma of the thyroid and resembled the histological appearance of clinical anaplastic thyroid carcinoma.

CLINICAL

The carcinoma patients exhibited significantly elevated levels of circulating catecholamine as compared with the controls. On the other hand, sarcoma patients did not show any significant change in the circulating catecholamine levels. Similarly,

PLASMA AND TISSUE CATECHOLAMINE LEVELS

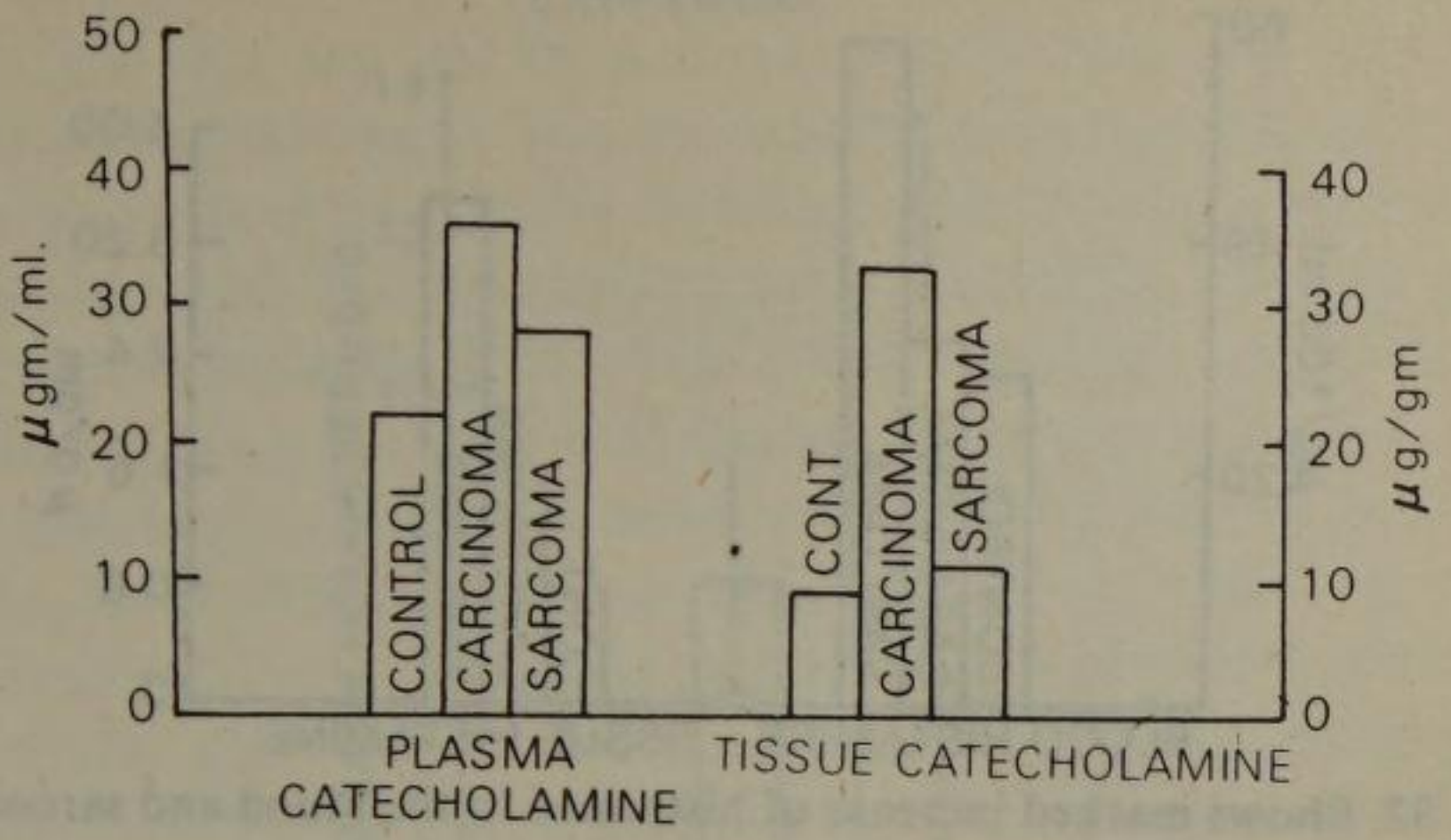


Fig. 80. Shows a significant increase of total catecholamines both in the plasma and cancer tissue.

TISSUE CATECHOLAMINE IN RELATION TO THE GRADE OF TUMOUR

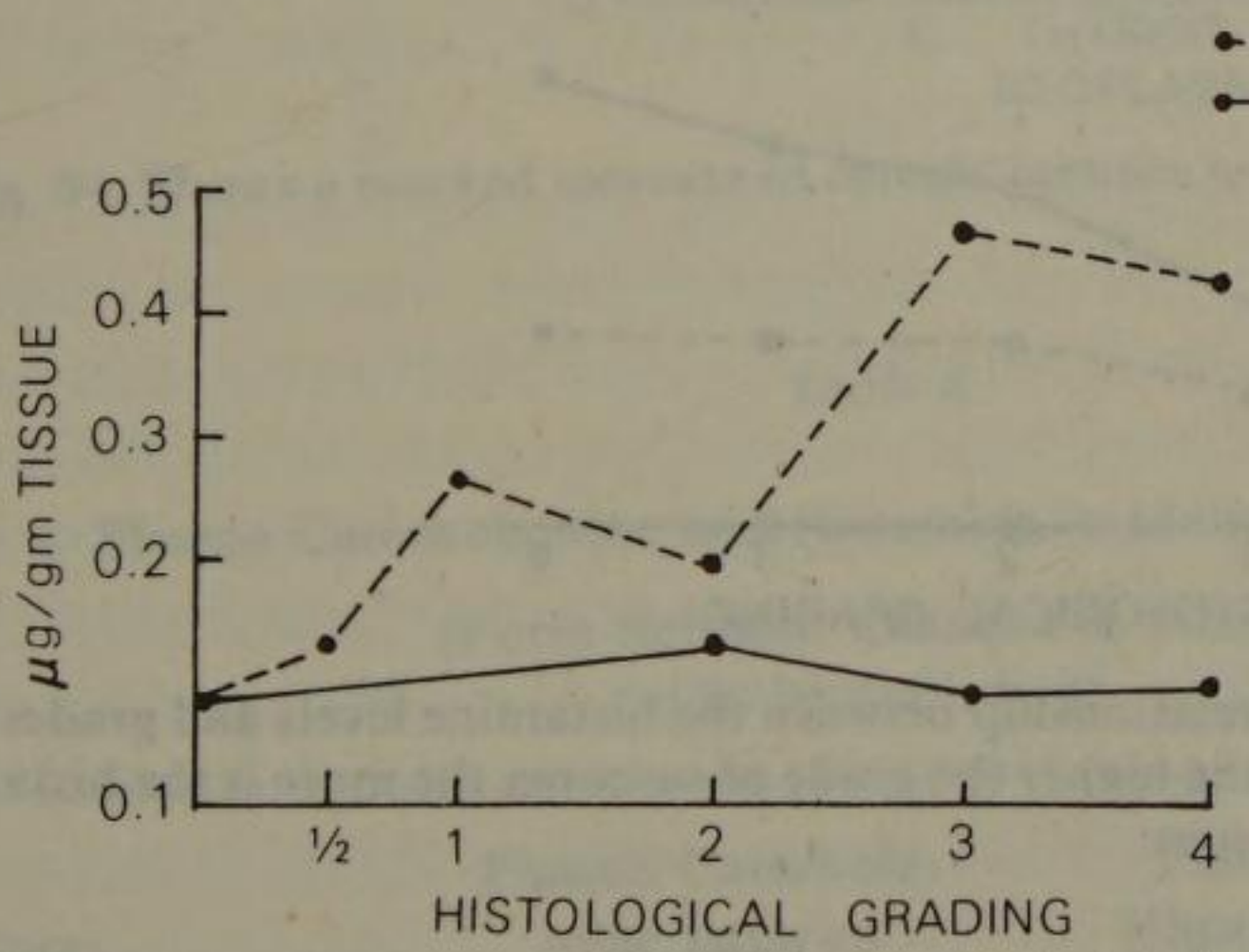


Fig. 81. Shows that the increase of tissue catecholamine is closely related to the grade of the tumour. Note that the higher the grade of the cancer, the greater is the catecholamine content of the tissue.

the plasma cortisol levels were found significantly increased in cases of carcinoma as compared to the controls, whereas the sarcoma patients did not show any significant changes. Blood histamine, on the otherhand, was not significantly changed in the carcinoma patients, whereas the sarcoma patients showed significantly elevated blood histamine levels as compared to the controls.

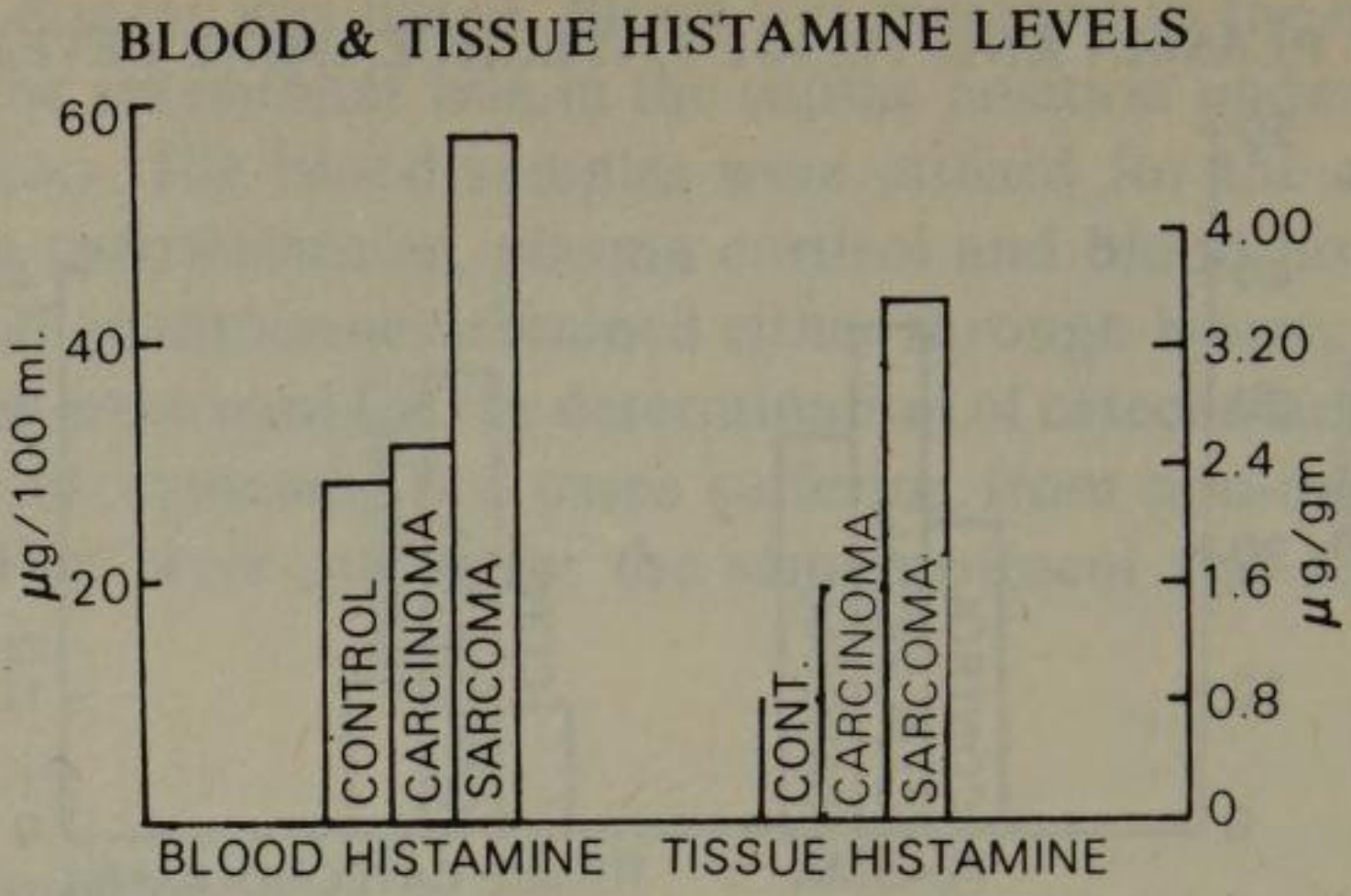


Fig. 82. Shows marked increase of histamine in the blood and sarcomatous tissues.

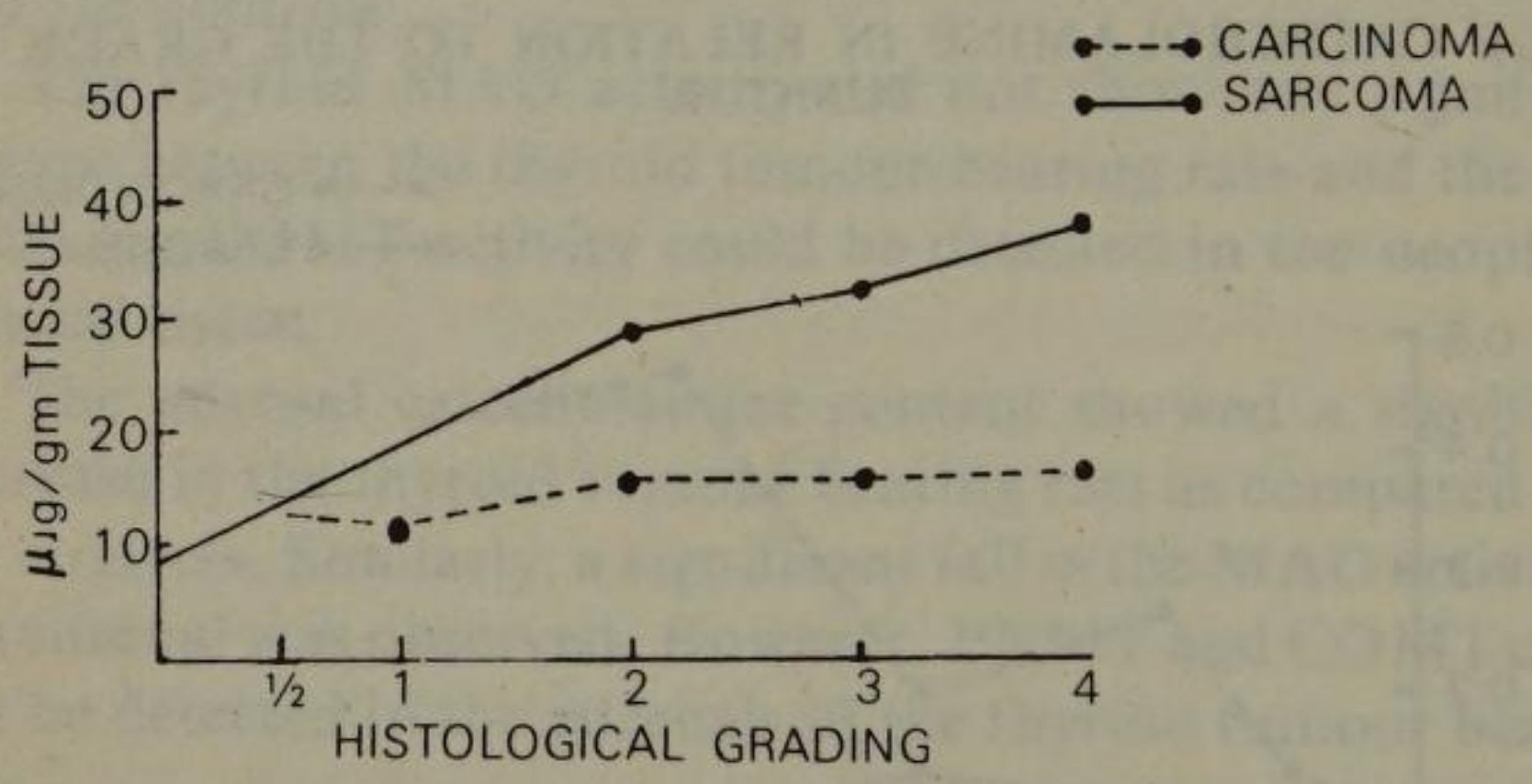


Fig. 83. Shows close relationship between the histamine levels and grades of sarcomas. Note that the higher the grade of sarcoma the more is the histamine content of the tissues.

The malignant tissue content of carcinoma patients showed a significant elevation in the catecholamine content as compared with the controls. However, the catecholamine content of sarcomatous tissue did not differ from the controls. The malignnt tissue histamine contents were found to be significantly increased in both carcinoma and sarcoma patients as compared with the controls. However, in the sarcomatous tissue the increase in the histamine levels was relatively more marked than in the carcinomatous tissues (Fig. 80, 81, 82, 83).

THYROID CATECHOLAMINES IN THYROID NEOPLASM C-CONTROL

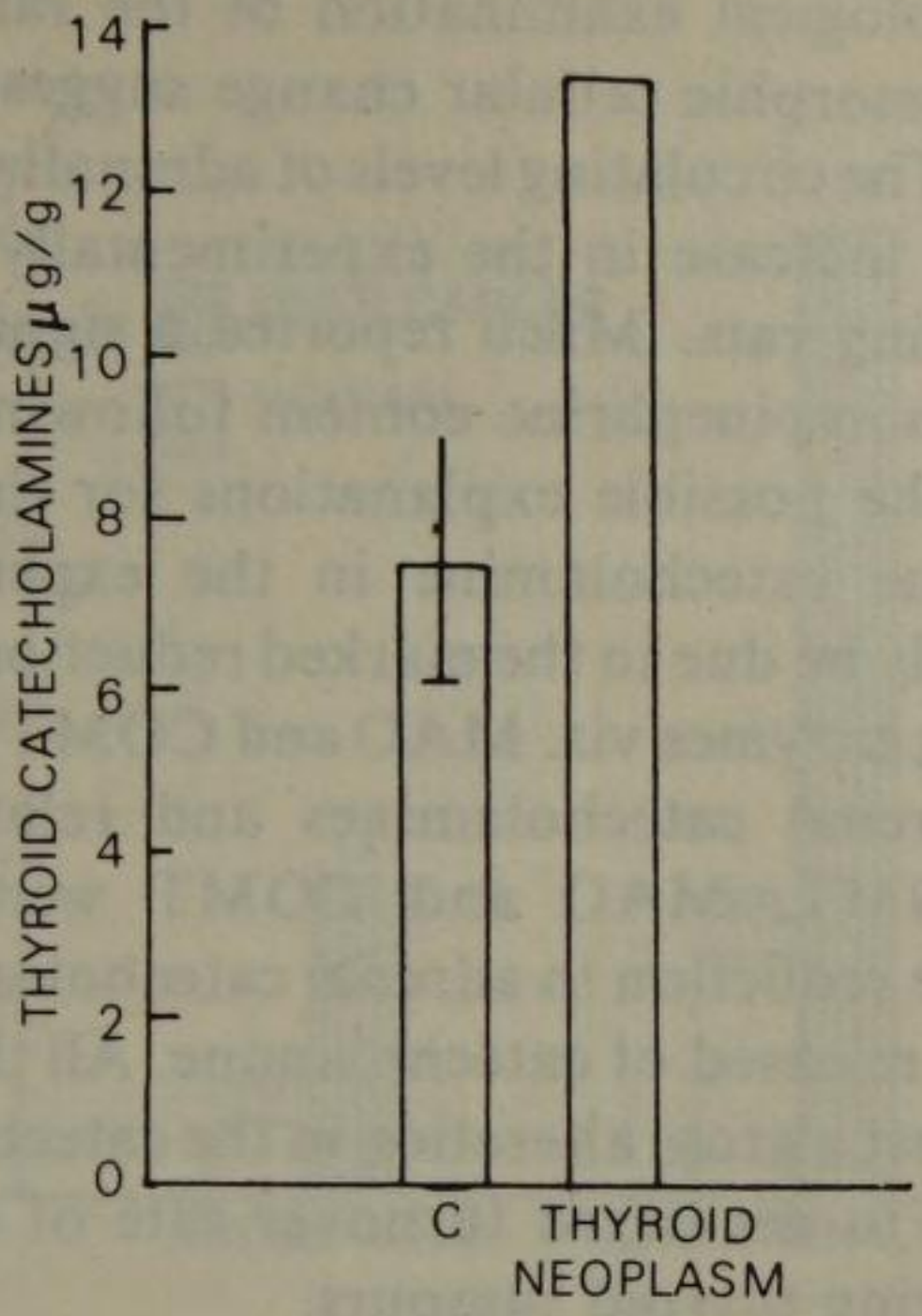


Fig. 84. Shows a marked increase of catecholamines in cancer of the thyroid.

Table 8.

Plasma Catecholamine and Histamine in Malignant Conditions

(Form Subhash Chandra & Udupa)
(To be published)

Cases	Plasma Catecholamine µgm/ml	Plasma Histamine
Control	22.57 ± 6.12	28.50 ± 8.83
Carcinoma	36.38 ± 6.34	30.86 ±18.58
	0.001	N.S.
Sarcoma	28.40 ±13.30	57.11 ± 2.27
P value	N.S.	0.001

Discussion

The histological examination of the rat thyroid showed marked pleomorphic cellular change suggestive of anaplastic carcinoma. The circulating levels of adrenaline and noradrenaline did not increase in the experimentally induced thyroid tumour bearing rats. Milcu reported a significant increase in the thyroid norepinephrine content following faradisation.

One of the possible explanations for the increase in the thyroid tissue catecholamine in the experimental animals could possibly be due to the marked reduction in the activity of its degrading enzymes viz. MAO and COMT (Fig. 84). In these animals, adrenal catecholamines and related metabolizing enzymes PNMT, MAO and COMT were also markedly reduced. The reduction in adrenal catecholamines may be due to increased released of catecholamine. All these observations tend to suggest a gross alteration in the catecholamine metabolism leading to decreased turnover rate of catecholamine in animals bearing thyroid tumours.

In the clinical cases of carcinoma, there was a significant increase in the plasma and malignant tissue catecholamines. This was also the case in plasma cortisol. Both plasma catecholamine and cortisol are known to increase in response to stress. However, in cases of sarcoma, though there was an increase in the plasma cortisol levels, the plasma and tissue catecholamine levels remained unchanged. In contrast, the blood and tissue levels of histamine are significantly enhanced in patients suffering from sarcoma, indicating some immunological reactions (Table 8).

From the experimental and clinical observations made in the present study, it appears that psychological stress plays some role in the development and progress of cancer which is possibly mediated through the release of catecholamines and cortisol from the adrenal medulla and cortex.

It is now well established that cortisol favours the growth of cancer through its immunosuppressive activity. However, the

A ADRENALINE AND NORADRENALINE IN LIVER CANCER PATIENTS

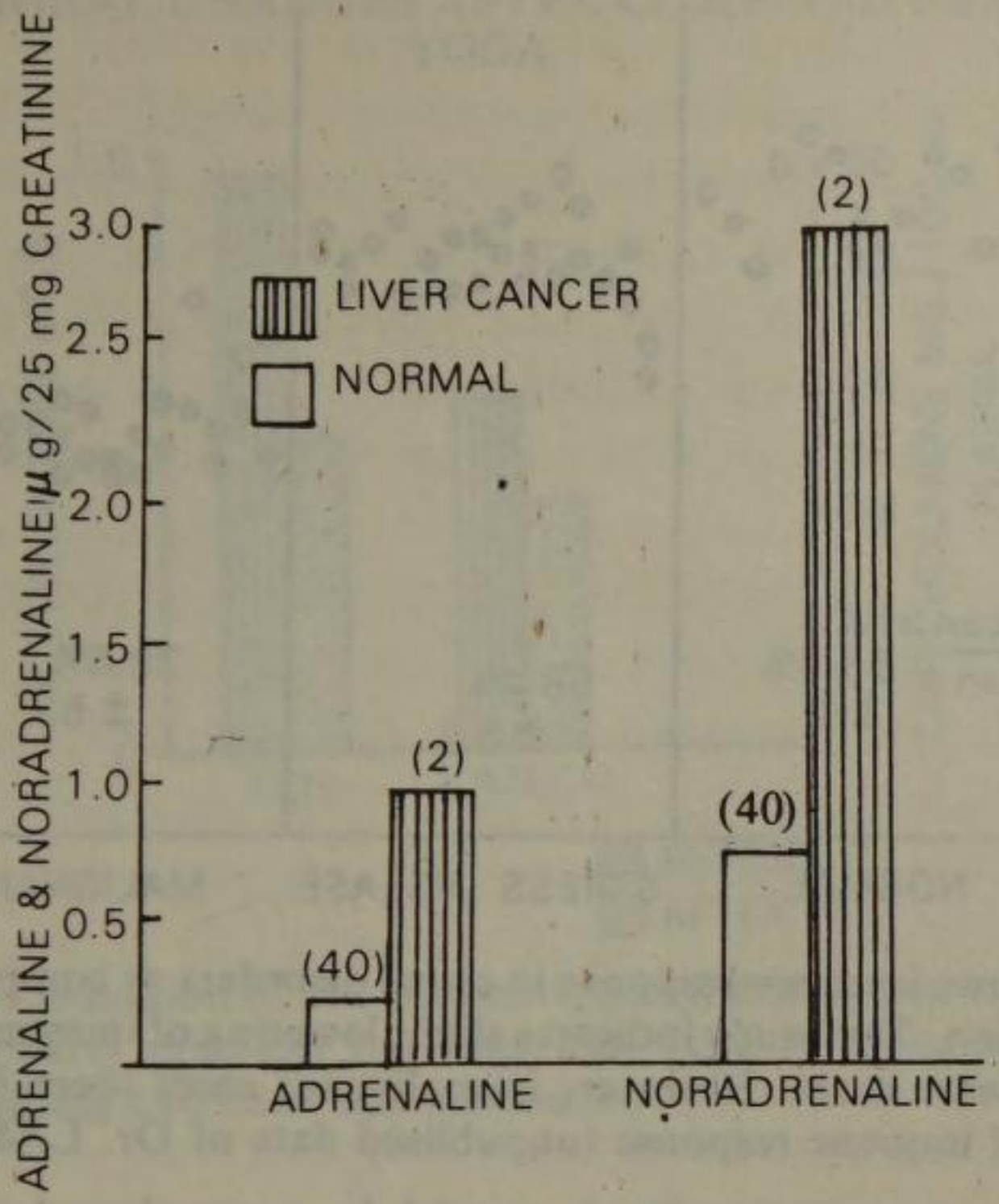


Fig. 85. Shows the enormous increase of adrenaline and noradrenaline content of cancerous liver in comparison with the normal one.

catecholamines act mostly through their local vasoconstrictive properties. It has been amply demonstrated that following stress, there is excessive release of catecholamines. As the stressful situation continues, one of the susceptible organs or tissues ultimately becomes victim of the disease, because of its weakness due to some genetic factor, or as a consequence of certain environmental factors after birth or in childhood. If the catecholamine continues to be elevated for a long duration, the blood supply to the susceptible organ is reduced leading to tissue anoxia. In case the anoxia continues for a longer period in a particular organ, the cells may transform into mutant cells which can behave abnormally or *in situ* mutant cells which are lying dormant may begin to multiply. The abnormal cells in the anaerobic environment can become malignant cells if such a condition continues for a long time (Fig. 85.). It has been demonstrated by Warburg that the cancerous tissues lack oxygen and these cells grow vigourously in anaerobic condition.

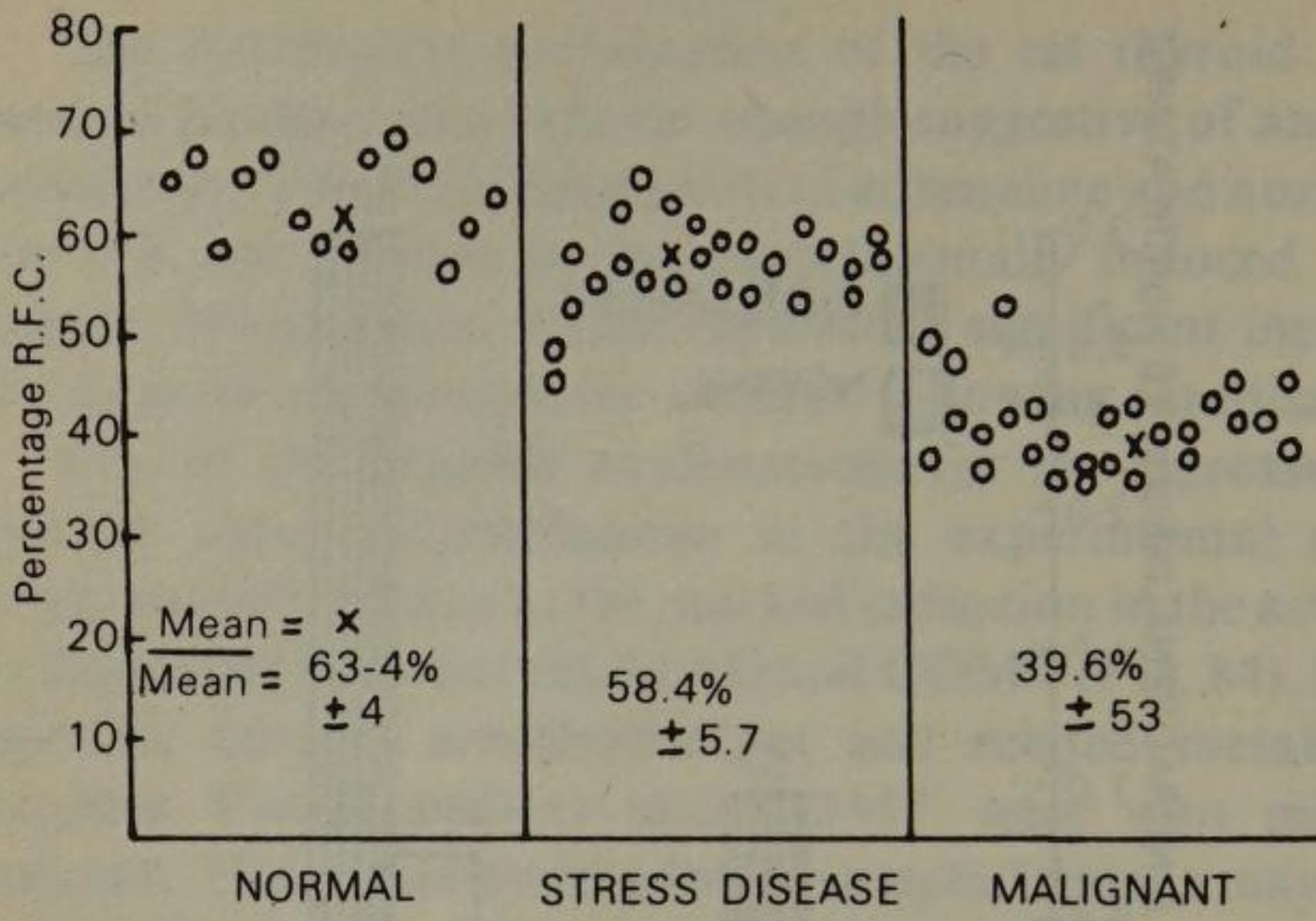


Fig. 86. Shows immune response in stress disorders as compared to malignant condition. This study indicates slight lowering of immunological states in stress disease cases. However, in malignant cases there is considerable reduction of immune response (unpublised data of Dr. L.M. Singh).

From the present study, it could be postulated that chronic tissue anoxia in a given organ induces anaerobic condition which leads to the development of cancer in due course of time. It could also be deduced that psychological stress may induce cancer, partly by producing immunosuppression through excessive release of cortisol and also by the excessive action of catecholamines by producing prolonged vasoconstriction and anoxia of the affected organs and tissues of the body. However, this does not seem to occur in the case of sarcoma, where a marked increase in blood and tissue histamine levels was observed, indicating some sort of immunological enhancement. Riley observed that the incidence of mammary tumour in experimental mice could be increased to 90% by exposing them to a variety of stressors, whereas the incidence in control mice was only 7%. Thus, he concluded that moderate, chronic or intermittent stress may predispose such mice to increased risk of mammary cancer and adequate protection from physiological stress may reduce mammary tumour occurrence in mice.

NEUROHUMORAL CHANGES AFTER COMBINED PRACTICE OF YOGA

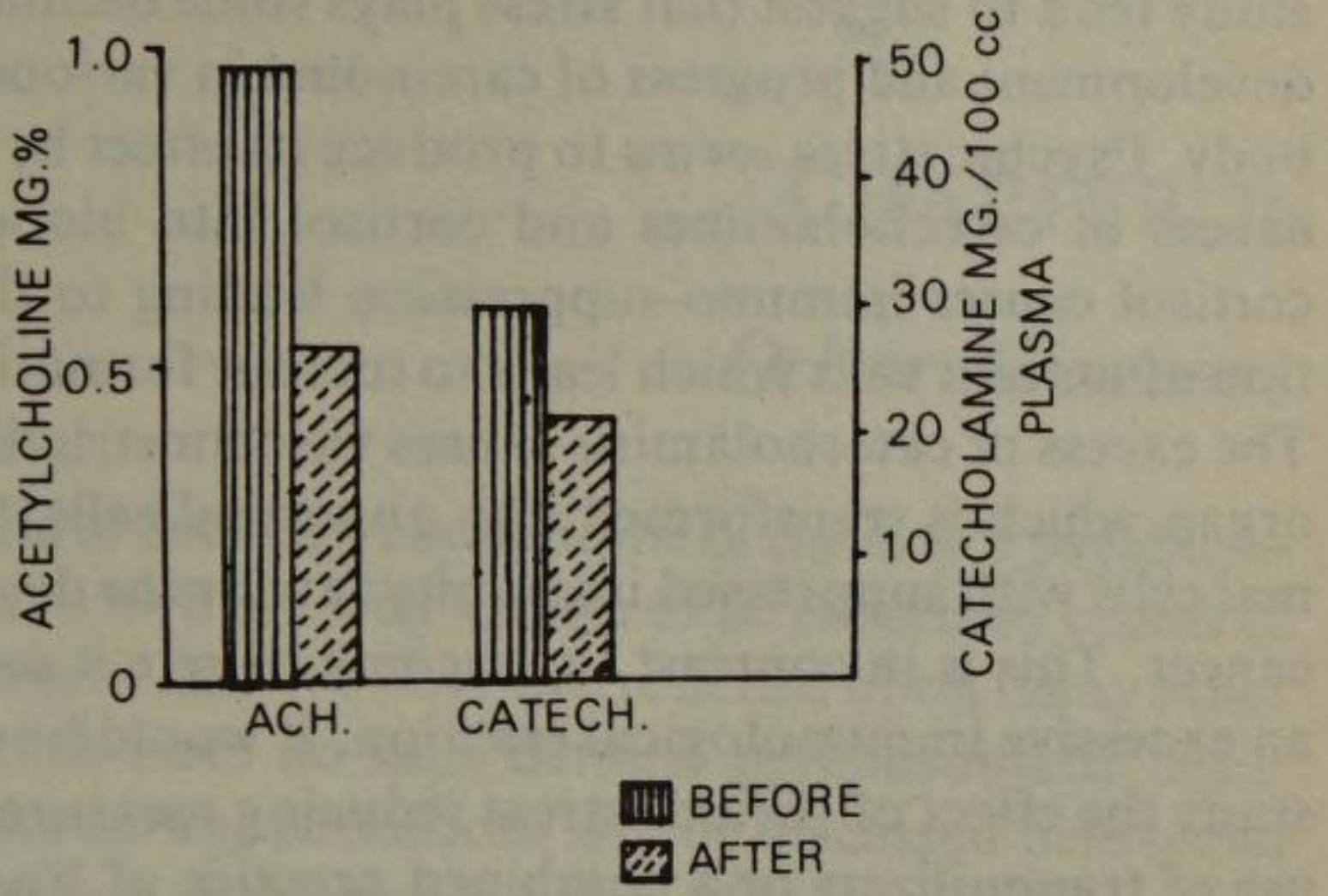


Fig. 87. Shows reduction of neurohumors, acetylcholine and catecholamine when one regularly practices the integrated type of yoga, namely, yogic postures, breathing exercises and meditation.

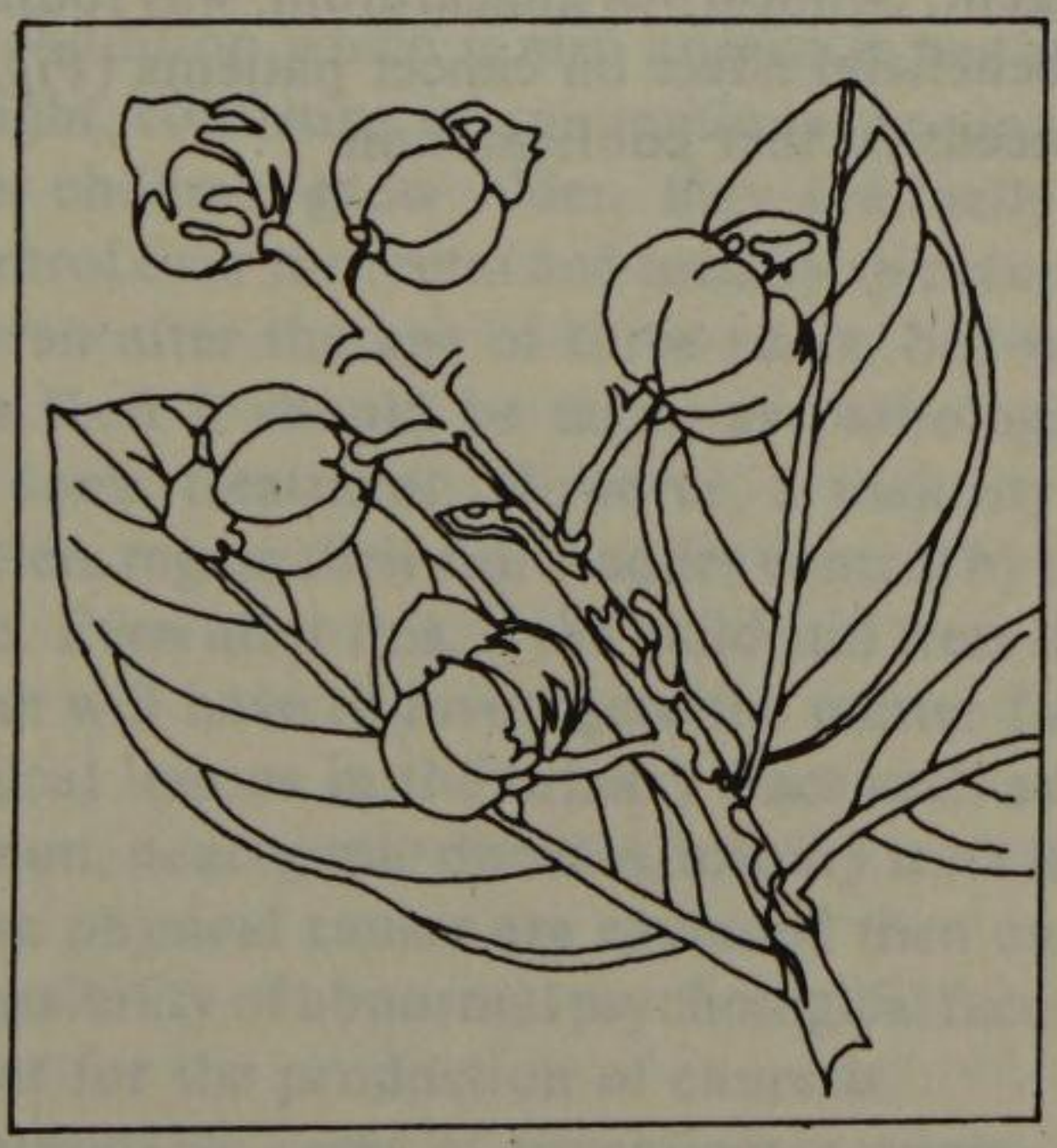


Fig. 88. Shows the picture of the herb, Semicarpus anacardium or "*Bhallatak*" in Sanskrit. It has been observed clinically that various preparations of its nuts have anti-cancer properties.

In conclusion, the observations recorded in the present study tend to suggest that stress plays some definite role in the development and progress of carcinoma in various parts of the body. Psychic stress seems to produce its effect by releasing an excess of catecholamines and cortisol into blood. Excessive cortisol causes immuno-suppression leading to the proliferation of mutant cells which leads to tumour formation (Fig. 86). The excess of catecholamine causes vasoconstriction of a weak organ which is transformed into abnormal cells. Such abnormal cells with suppressed immunity favour the development of cancer. This is in contrast to sarcoma, where it seems, there is an excessive immunological reaction. It would be of interest to study the effect of various stress reducing measures such as the use of tranquilizers or a combined practice of Yoga which are known to decrease both the circulating levels of catecholamines and cortisol, in the prevention and control of cancer (Fig. 87). Recently, one of the indigenous restorative and stress reducing agent, Semicarpus anacardium, was found to be having some beneficial effect on cancer patients (Fig. 88). However, this needs further confirmation.

CHAPTER 26

Other Diseases

So far we have been discussing some of the major psychosomatic diseases, which are well known to be caused by excess of stress and strain in life. We have not touched upon many other conditions which have no such definite psychosomatic basis. Some of the borderline conditions will be discussed below and also our experience in the management of some of their victims with the help of Yoga.

Enuresis

This is a condition which is also known as bed-wetting in children at night, consisting of unintentional passing of urine. Normally, as children grow older, they gradually develop voluntary control over the rectal and urinary spinctures. However, when even after the age of three years, bed-wetting at night persists then it should be taken as pathological state which needs some treatment. However, a majority of even these bed-wetters regain their full bladder control by the age of 10 years or so. Even after this, if the child still wets the bed at night then one will have to investigate the matter for having any pathological lesions in the urinary tract such as bladder neck obstruction, neurogenic diseases, urinary tract infections etc. If all these physical causes are excluded then one should suspect the possibility of abnormal psychological factors as the causative agent for the production of enuresis.

In such intractable cases of psychogenic origin, with the disease continuing even after puberty, several psychotropic drugs had been tried such as Amphetamine and Imipramine (Tofranil) with some beneficial results. Some workers have

even suggested an alarm system to be attached to the bed which gives alarm the moment it starts wetting. However, this does not treat the main psychological factors responsible for producing enuresis. Even after giving psychotherapy to these patients one does not get any desired results. Hence we advise yogic practice in such intractable cases of enuresis of psychogenic origin with remarkable good results. A history of one such case will illustrate the point.

Miss K. aged 21 years had been wetting her bed since childhood. Sometimes, such bed-wetting would be almost every night especially in winter season, whereas in summer it occurred only once in a while. She could not go anywhere outside her home because of the fear of wetting the bed at night in those places which would put her in an embarrassing situation. Hence, though she was a grown-up girl, psychologically she had a stunted growth and was very shy and introverted in her behaviour. For overcoming this trouble, the family physician had undertaken all the investigations, physical and psychological, to find out any lesion. Since nothing physically abnormal was detected she was put on amphetamine one tablet twice a day for six weeks with no relief. Then she was put on Tofranil for 2 months with no visible change. Then her parents came to me for consultation and we suggested a course of yogic exercises comprising 6 common postures (See Appendix) daily. To our great surprise the patient completely got over this disability within a period of 3 months to full satisfaction of the patient and her relatives. We have now followed this patient for a period of 6 years with no evidence of any recurrence and she is now leading a happy married life.

From this one can conclude that enuresis of psychogenic origin can be effectively treated by yogic practice. It seems that by practicing Yoga, the central nervous system starts exerting greater influence on the Micturition Centre in the spinal cord leading to better control and coordination of the process of micturition. Therefore, one should try this method in the management of some of these intractable psychogenic enuresis cases.

Epilepsy

This is a convulsive disorder which usually starts either in childhood or around puberty. The severity of such a convulsive attack varies from single attack after a year or so to several attacks per day. Because they are generalized seizures, these attacks may pose a constant threat of injury such as when occurring near a fire-place or water reservoir leading to serious consequences. The diagnosis is usually made by the typical history and also by the typical findings in EEG. In the history, one could suspect a cortical lesion, during the intrauterine life or neonatal period, or the presence of noxious chemical agents, trauma or infection in later life. Once the diagnosis is fully established one will have to plan specific treatment depending upon the causative factors and severity of the attacks. After planning the removal of precipitating factors one will have to advise a prolonged intake of modern anticonvulsive agents such as Luminol, Dilantin, Mysoline, Mesantoin, Mebarol etc. Apart from the use of these drugs which would selectively produce their action on the affected point of the brain, there is a need for giving psychotherapy and also psychic restorative therapy. Otherwise, many times though the patients are free from seizures, they remain mentally subnormal and depressed and hence, lose all the interest in leading a normal life. In such cases, psychotherapy alone may not be sufficient and so we recommend some form of yogic therapy which might help the patient to get over the inferiority complex. Such a practice may also reduce the quantity of intake of drug and may also reduce the duration of treatment. Dr. Ramamurti and his colleagues in Madras are trying the biofeedback system by which they expose the patients to the alpha waves from external sources with some gratifying results. Our own experience with the use of yogic measures in epilepsy is limited to only five cases. Although we cannot make any definite statement in this regard, we do feel that this is an area which needs much more research to establish the utility of yogic therapy. A patient who is presently undergoing yogic therapy is free from the attacks for the last 6 months and we have reduced the intake of

anticonvulsive agents by 50% without any untoward incident. Hence, we feel there is a great scope for improving the overall result of treatment by including Yoga therapy as an adjuvant treatment in epileptic cases.

Psychiatric Disorders

It is not yet quite clear whether yogic measures have any role to play in the well established cases of psychiatric disorders. Earlier, we have already discussed the role of yogic measures in various types of neurosis especially anxiety neurosis. However, in well established cases of personality disorders and psychotic conditions, yogic measures do not seem to be having much beneficial effect. But, it is expected that as in the cases of other psychosomatic conditions, if Yoga therapy is instituted in the initial stage of the disease along with known therapeutic measures, it might help to overcome the disease. This is specially so in the early cases of Schizophrenia, in whom we had some experience of advising yogic exercises with gratifying results. However, this problem needs further study and assessment.

Similarly, in cases of drug addiction and chronic alcoholism also, transcendental meditation has been tried by many workers with good results. The results were specially gratifying in the intractable cases of drug addiction for which there is no satisfactory method of management. There is obviously a great scope for further study in all these psychiatric conditions especially of the role of various methods of Yoga therapy either as principal therapy or as an adjuvant.

Skin Disorders

It is well known that psychological changes are directly reflected on the skin through the autonomic nervous system especially the sympathetic nerve endings. Thus, if one gets an emotional disturbance, it is directly reflected on the colour and temperature of the skin which is brought about by the changes in its microcirculation. It is well know that those who have a better control over their emotions either congenitally or as a

result of training and learning, will have comparatively by less amount of skin changes after any such emotional disturbances. There are expert yogis who have mastered the technique of voluntary control over the involuntary functions. These people through regulating their sympathetic nervous system can modify their body temperature at their will. Thus, they can raise the temperature of the right hand by 3° F and at the same time can reduce the temperature of the left hand by 3° F. It is this fact which ultimately led to the development of skin biofeedback system by measuring its temperature before and after undergoing the relaxation posture. In fact, there are simple skin temperature measuring devices for the extremities by which one can always assess how much one is emotionally disturbed at a given time and how much he can be benefitted by his subsequent practice of *Shavasana* type of yogic practice everyday. This matter has been further discussed in greater detail in the chapter on biofeedback. It should be noted here that skin and its appendages like sweat glands are richly supplied by the sympathetic nerves. As a result, any stimulation or depression of the sympathetic nervous system will produce pathological state of the skin. Because of this, all the stress diseases of the skin such as neurodermatitis, eczematous dermatitis, hyperhydrosis, psoriasis etc. can be assisted by various yogic measures including skin biofeedback and relaxation postures.

As in the case of others various tranquillizers can help the patients only temporarily to tide over their acute conditions. However, in order to reduce the sympathetic overactivity in all such cases, the relaxation posture type of yogic exercise and also meditation would be of great help as an adjuvant treatment. So far we have not subjected any of our cases to this type of treatment. However Dr. Melkote, presently of Yoga Institute, Tirupathi, had a unique experience of treating a large number of psoriasis cases with Yoga therapy with remarkably good results. From these preliminary observations of Dr. Melkote, one can say that there is a great need for making further studies on the role of Yoga therapy as an adjuvant in the treatment of stress induced skin disorders.

CHAPTER 27

Conclusion

Historically speaking, Virschow and his colleagues were the first to lay down the foundation of modern cellular pathology in the middle of the 19the century. Since then, modern medical scientists have been making full use of this basic knowledge for understanding the various disease processes in order to make correct diagnosis and offer accurate treatment. Because of its utility, modern medical men devoted most of their time to the understanding of the pathological changes occurring in each organ in great detail and the pathogenesis of development of such a disease process, and the early manifestations were given comparatively less importance. This is possibly because of the fact that various functional and biochemical changes that occurred during the early period of these disorders could not be established fully due to the lack of accurate methods.

As a result, the study of pathology of each organ was considered as a separate and independent entity. This led to the establishment of many specialities and subspecialities in modern medicine. In spite of an enormous progress made in these special fields during the past half century or so, we still do not know how exactly all these systemic stress diseases are caused and how one can prevent the development of these diseases. Further, as our urban civilization and industrialization increases the incidences of many of these stress diseases such as hypertension, inchaemic heart diseases etc. are also rising at an alarming rate. Hence, we must establish the correct etiology and pathogenesis immediately in order to take prompt preventive measures against these rapidly increasing systemic disorders.

It is at this stage that one might get some idea from our ancient Indian medical literature which has emphasized greatly the holistic approach in the entire Medical Science. In the ancient Science of Ayurveda they take man as a whole with his entire psychosomatic constitution. In addition, they have described three humors which regulate all the bodily functions during health and disease. Along with this, they have also attached great importance to the well-being of sense organs, mind and spirit for maintaining a healthy psychosomatic personality. It is now known that centres for all the above-stated psychic activities are located in our brain.

Taking some clues from these ancient Indian medical thinkers we postulated that the brain with its known centres for the sensory and mental functions might be playing the main role in maintaining the balanced state of the entire body during all the stress and strain of life. The brain is able to maintain such a correct homeostasis by liberating various neurohumors, which our ancient medical men labelled as *dhatus* or humours. Amongst the various neurohumors three namely acetylcholine, catecholamines and histamine and its related substances appear to be the principal ones, and the remaining neurohumors may be taken as secondary ones. The cerebral cortex regulates the functions of the entire body not only by sending its nerve impulses to organs and tissues but also by regulating the microcirculation to each organ through the liberation of neurohumors in appropriate quantity. It is through this neurohumoral liberation that various hormones are secreted in the required quantity to meet the needs of all the bodily tissues and organs. In short, in holistic medicine it is the healthy state of the cerebral cortex which is the seat of all our psychic activities, balanced output of required quantity of neurohumors and hormones, which ultimately leads to the normal functioning of all the organs and tissues of the body. From this it follows that if there occurs any excess of environmental disturbances which are conveyed to the brain centres through the sense organs, then the functional disturbances may take place in various organs and tissues through the mediation

of disturbed neurohumors and hormones. Therefore, if one wants to study the pathogenesis of any such disorders one will have to study the disturbed state of psychic functions, disturbance of neurohumoral and hormonal patterns before one actually studies the disturbed functions of individual organs. It is here that the recent advancement in the study of neurohumors and hormones which has helped us greatly to measure these changes biochemically, has made a correct appreciation of their role in health and disease.

In fact, if one fully understands the role of these three neurohumors especially in regulating the microcirculation of our body, one can really appreciate their main role in the pathogenesis of various stress diseases. It is this fact which we emphasised greatly in this monograph.

In addition to the disturbance of environment there are two other factors which may be responsible for the development of stress diseases. Firstly there may be genetic factors which increase the susceptibility of a person to get a particular type of stress disease. From our studies, we can say that genetic susceptibility is possibly transmitted in the form of relative decrease or increase of various degrading enzymes of neurohumors such as cholinesterases, monoamine oxidases or histaminases. Thus, if the enzyme MAO is less there is obviously increased activity of catecholamines leading sooner or later to some type of cardiovascular diseases.

The second factor is the presence of interoceptors in all the viscera, endocrine glands and blood vessels. Any disturbance at these sites will ultimately lead to disturbance in the respective centres of the cerebral cortex, which may also contribute to the development of some of the stress diseases directly or indirectly. However, this area needs further study. Once the stage has set in for the development of stress diseases due to any of the above-mentioned facts, there occur 4 stages in the pathogenesis of the disease.

At first the neurohumoral changes are mostly limited to various centres of the cerebral cortex leading to mainly psychic disturbances. In the second stage, the disturbances spread to

the hypothalamus and through it to autonomic nerves and neuroendocrine apparatus. At the third stage, the entire body neurohumors are disturbed causing functional changes in the whole body, and at the fourth stage the disease settles down in one of the susceptible organs or tissues. Even when the disorder has settled down in an organ, at first there occur only functional changes. Thereafter, there occur inflammatory changes in that organ including ulceration as a result of the development of autoimmune response brought about by the microcirculatory changes. It is needless to say that these changes in the individual organs and tissues are also brought about by various neurohumoral changes that occur in the process. Ultimately, as the process of autoimmune phenomenon subsides, the natural healing phenomenon sets in, which usually leads to fibrosis in that organ or tissue. Thus, atherosclerosis, pyloric stenosis, emphysema (after bronchial asthma) and hypothyroid state are some of the sequelae of the self-limiting processes of various disorders of stress.

From all this we can conclude that the main initiating factor in the development of stress disorders is the increased liberation of neurohumors by the excessively stimulated cerebral cortex. Therefore, it is now understandable that if one can learn to restrain the cerebral cortex, especially its psychic centre, one can be free from the development of various stress disorders throughout one's life.

It is here that Yoga can be of immense help to all in preventing the development of stress diseases, and thereby living a long happy and healthy life. In this connection the famous sage Patanjali says that a few people in society are resistant by nature to every type of disorders of stress, a few others develop such resistance after birth by the prolonged use of some of the restorative medicines, and most of the other people can develop such resistance only by the practice of various types of Yoga. The sage Patanjali has described eight limbs of yogic discipline (*ashtanga yoga*). Amongst them three, namely postures (*asanas*), breath holding exercise (*pranayama*) and meditation (*dhyana*) are the important ones for

our purpose. We found in healthy normal individuals that a regular practice of all these yogic procedures brings the neurohumoral pattern to normalcy. Thus, if there is an excess of a neurohumor it becomes less, and if there is less of other neurohumors or hormones they become increased, to come to the normal level. In addition, it also improves the functional efficiency of all the organs and tissues by improving their microcirculation.

One often asks how this yogic practice brings about the changes in the cerebral cortex and thereby in the neurohumoral content. Modern physicists put forward a theory that the level of human consciousness depends upon the mobility of atomic components of the human brain. If one can increase the mobility of these atoms by the practice of Yoga, one can improve consciousness to a higher level. Here, one should also remember that the more sensitive is the area, the more will be the effect of Yogapractice on that particular area. Thus, the psychic centre which is also supposed to be the area for spiritual growth, becomes highly efficient in performing its function after the practice of Yoga. Therefore, it becomes more efficient in controlling the centres of emotions, hunger, thirst etc. present in the limbic cortex and hypothalamus. Gradually, one can develop the power of voluntary control of involuntary functions of the body leading to more efficient functioning of the body and mind. These are some of the important hypotheses put forward bv many workers, and our study both of healthy persons and the patients of stress disorders, fully confirms the above observations.

In addition, we had also the unique experience of treating nearly 400 patients of different stress disorders who underwent Yoga therapy with or without the help of biofeedback with remarkably good results (Table 9). In young patients with relatively recent history of stress diseases, yogic practice greatly helps in giving permanent relief. In older people, Yoga therapy can only act as adjuvart treatment to alrealy well established medical or surgical treatment. But the most important thing to remember in this context is that yogic practice can play a great role in the prevention of various stress diseases

provided it is practiced with all sincerity and in a regular manner. Therefore, it is hoped that more and more medical men will study this problem in great depth and make use of this practice to the fullest extent in the interest of humanity as a whole.

Table 9.

Follow-up Results of Yoga Therapy

Sl. No.	Disease	Total cases	Clinically Cured	Relieved	No Significant change
1.	Hypertension	91	47	22	22
2.	Diabetes Mellitus	63	37	17	9
3.	Bronchial Asthma	85	43	30	12
4.	Anxiety Neurosis	127	87	25	15
5.	Thyrotoxicosis	56	33	12	11
6.	Chronic Colitis	104	51	38	15
7.	Rheumatoid Arthritis	159	100	33	26
8.	Miscellaneous	101	58	23	20
	Total	786	456	200	130
	%		58%	25.5%	16.5%

CHAPTER 28

Epilogue

SOCIAL ASPECT OF YOGA

Everyday we realized that this world is moving at a faster rate than before. This is mostly due to the fact that science and technology are making a tremendous progress in every sphere of our activity. It is surprising that while making such a spectacular progress in the external materialistic world, we have comparatively made very little progress with regard to our understanding of man and his internal environment. In fact we have almost forgotten to take up this subject for our study. It is in this respect that our ancient sages have made remarkable contributions to the understanding of man, which can hold true even today as described in *Kathopanishad*. Hence what we urgently need at present is a synthesis of our understanding of external world as per modern science and technology and the study of internal world of man as per the study of our ancient sages.

Therefore the time has now come for a joint enterprise on the part of the modern scientists and the custodians of ancient wisdom so that something good may come out for the betterment of humanity as a whole. As Paul Brunton states, "Progress follows from the top, from leading circles and higher classes of every community downwards until it permeates the populace. The ideas and beliefs held by the most educated and enlightened ones slowly come to be received by those below. Their outlook and attitude count most in influencing the world. Therefore, it is to them particularly that the hidden philosophy is now addressed. The enthusiastic activities of European Scientists can now be harmonised with the calm contemplation of oriental sages." In recent years many Euro-

peans and Americans have made many attempts. However, it is surprising to see that comparatively very few noted scientists have taken much interest in these most valuable sciences of man. They are still hesitant to take up such a project as could unravel the mysteries of human life. However it is expected that in the very near future more and more scientific institutions and scientists will join their hands with people of East to unravel the truth of man and his inner self.

It is surprising that even in India, there are only a few true experts on Yoga, who have shown some interest to join their hands with modern Scientists to explore the mysteries of this science for the betterment of humanity as a whole. Many Western scholars come to India, visit various centres and return home without encountering a good centre where Yoga is studied more scientifically and systematically for adoption by the rest of the world. They usually find a vast amount of literature on the subject, but can meet hardly any men with modern scientific outlook and also conversant with ancient literature on Yoga. After touring the entire country in search of authentic yogis and yoga centres, Paul Brunton wrote the following in a desperate situation: "For the general motive that governed my researches reflected itself in my main aim in the writing the book, which was to draw European and American people to the much neglected path of inner peace. And general Western attitude was that it had no use for the moribund survival of yoga any more than for other superstitions of a senile and sterile India. I had therefore to show that yoga at least possessed some living value." Unfortunately even today various yoga institutions are in a stage of disarray. There is no standard and many unqualified people are doing unethical practices in Yoga not only in this country, but also all over the world. Discussing this unfortunate situation Paul Brunton states, "Yoga had been thought largely useless to the modern world, because it was held tight by fanatic faqueers in the crippling and unfortunate embrace of superstition. Dogmatic religion had deflected much of it from its psychological goal, whilst primitive magic had distorted another portion of it into a circus performance."

How sad is the state of Yoga in India! Our ancient sages have made such a remarkable original contribution to the welfare of man. But the modern scientists of our own country do not take the trouble of making any attempt to explore scientificially this most important treasure of human knowledge. Nor they encourage Western scientists to come over here to collaborate with the genuine Indian workers to delve deep into the subject. It is really great human tragedy and God alone knows how long such a situation lasts. India Government has been generous enough to constitute a Central Council for Research in Yoga a few years ago, but it has yet to come off the ground level due to initial teething troubles. If at all any one group of people can be blamed for this pathetic situation in the field of Yoga, it is the Indian scientists, both pure and applied, including the medical men, who are largely responsible for the continuation of such a deplorable situation in the field of scientific study of Yoga. In this connection it is gratifying to know that the Indian Academy of Yoga has started functioning recently with its headquartes at Varanasi. Still it will take quite some time before they will be in a position to rejuvenate this great ancient science. However, one should thank some of the Western scientists and medical men who have recently initiated some useful studies in this field and we should await their results in the years to come.

In this respect it is worthwhile to recall the state of Zen Meditation in Japan. The word, "*Zen*" is nothing but "*Dhyana*" or concentration of yogic practice. This science reached Japan via China from India and then it flourished very well in a modified form. Paul Brunton writes on the subject as follows: "Japs never became blind adherents of the Indian born and Chinese transmitted customs. They used what was applicable to their own needs and rejected the rest. The ultimate aim of Zen was to create keen determined men with crisp clear mentalities who would be calmly active and skillfully concentrated in all their undertakings, who would spontaneously sink self in the service of their country. The dull lethargy, spectral melancholy, and anti-worldliness of many Indian monks did not suit

such a vigorous, optimistic and practical race..... Many of Japan's most famous soldiers, statesmen, artists, and scholars were Zen trained men. Their ideal was a perfect balance of the inner and outer man with efficiency as the keynote of both; the quality of their meditation was so high that a half-an-hour daily practice was sufficient to keep them in contact with spiritual peace. Thus their worldly life did not suffer but was enriched." While the Japanese could adapt Zen to suit their requirement for modern society, India has yet to modernize and standardize its yogic methods to suit the modern youths and other people of this vast country. It is this lack of understanding of the need of the modern Society of this country and abroad, which has delayed the universal acceptance of Yoga as a measure to maintain a perfect physical, mental, spiritual and social health.

However, there are silver linings in all the dark clouds. There are quite a number of private organizations and individuals who are trying to interpret the science and philosophy of Yoga both in this country and in many of the Western countries. Some of the well known Yoga Institutions which are functioning well in the country are listed below. The details of their activities can be obtained by writing to the Heads of these Institutions. This list is by no means exhaustive and a number of them might have been omitted due to the non-availability of fuller information. It should be noted that there is no single Yoga organization dealing with every aspect of Yoga.

List if Yoga Institutions

1. Kaivalya Dhama, Lonavla, Maharastra.
2. The Yoga Institute, Santa Cruz, Bombay.
3. Ramamani Iyenger Memorial Yoga Institute, Poona, Maharastra.
4. Aurobindo Ashram, Pondicherry.
5. Anandashram, Pondicherry.
6. Divine Life Society, Rishikesh, U.P.
7. Bihar School of Yoga, Monghyr, Bihar.
8. Shri Ramanashramam, Teruvannamalai, Tamilnadu.

9. Siddha Yoga Pith, Ganeshpuri, Thane Distt., Maharastra.
10. Satya Sai Institute of Higher Learning, Prashanti Nilayam, Puttaparthi, A.P.

In short, there is a vast scope for undertaking massive efforts to explore scientifically, the Art and Science of Yoga and then spread the message among the common men not only of this country, but of the whole world.

APPENDIX

Disease	*Asanas Recommended*	*Kriya Recommended*	*Pranayama Recommended*
Bronchial Asthma	Shirshasana, Dhanurasana, Chakrasana, Sarvangasana, Matsyasana, Shalabhasana, Bhujangasana, Halasana, Paschimottanasana, Matsendrasana, Yogamudra, Mahamudra, Supta Vajrasana, Padahastasana.	Dhauti, Neti, Kapalabhati, Vamana, Nauli, Uddiyana	Ujjayi, Shitali, Bhastrika
Hypertension	Shavasana, Shirshasana, Pavanamuktasana, Sharirasanchalana, Bhujangasana, Shalabhasana		Suryabhedana, Chandrabhedana, Ujjayi

Disease	*Asanas Recommended*	*Kriya Recommended*	*Pranayama Recommended*
Diabetes	Mayurasana, Dhanurasana, Bhujangasana, Halasana, Sarvangasana, Matsyasana, Paschimottanasana, Matsendrasana, Naukasana, Pavanamuktasana, Padahastasana	Nauli, Uddiyana, Dhauti, Sankhaprak-shalana	Bhastrika
Anxiety Neurosis	Shalabhasana, Bhujangasana, Trikonasana, Viparitakarani, Sarvangasana, Matsyasana, Halasana, Paschimottanasana, Pavanamuktasana, Vakrasana, Matsendrasana, Padmasana, Sharirasanchalanasana	Kapalabhati, Uddiyana, Nauli	Ujjayi, Anulomaviloma
Thyrotoxicosis	Sarvangasana, Shalabhasana, Paschimottanasana, Matsyasana, Bhujangasana, Trikonasana, Halasana, Dhanurasana, Matsendrasana	Kapalabhati	Bhastrika
Chronic	Mayurasana, Sarvangasana,	Nauli,	Sitalipranayama

distorders	Bahujangasana, Halasana, Dhanurasana, Chakrasana, Shirshasana, Pavanamuktasana, Naukasana, Yogamudra, Sharirasanchalana, Viparitakarani, Padmasana	Kapalabhati, Dhauti
Rheumatoid Arthritis	Dhanurasana, Chakrasana, Sharirasanchalana, Trikonasana, Shalabhasana, Bhujangasana, Akarna Dhanurasana, Supta Vajrasana	Kapalabhati, Dhauti
Headache	Trikonasana, Bhujangasana, Shalabhasana, Paschimottanasana, Vakrasana, Matsyasana, Akarna Dhanurasana	Neti, Kapalabhati, Jala-Neti, Vyutkarani.

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